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Radio-Electronics

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SPECIAL ISSUE
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ELECTRONIC GAMES

$1.50 JUNE 1983
U.K. 85p

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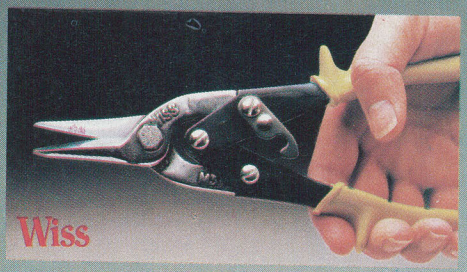

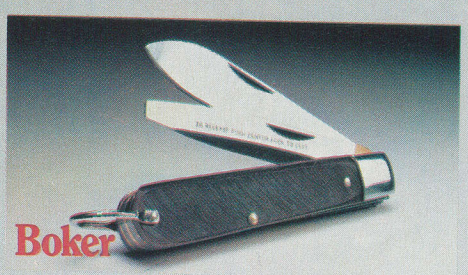

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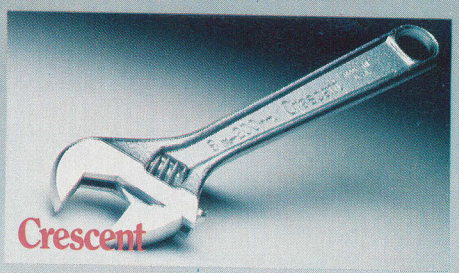

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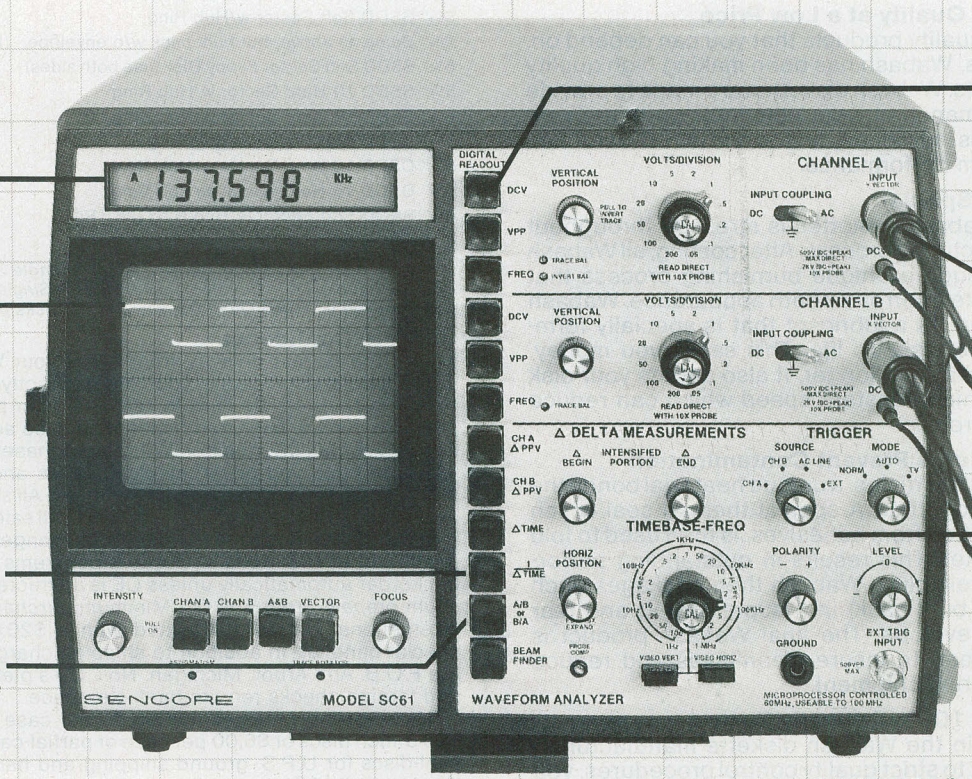

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8" DSDD Soft Sector (256 B/S, 26 Sectors)	F144	3.19
3" DSDD Soft Sector (512 B/S, 15 Sectors)	F145	3.19
8" DSDD Soft Sector (1024 B/S, 8 Sectors)	F147	3.19
5¼" SSSD Soft Sector w/Hub Ring	M11A	1.59
5¼" Same as above, but bulk pack w/o envelope	M11AB	1.39
5¼" SSSD 10 Hard Sector w/Hub Ring	M41A	1.59
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5¼" DSDD Soft Sector w/Hub Ring	M14A	2.79
5¼" DSDD 10 Hard Sector w/Hub Ring	M44A	2.79
5¼" DSDD 16 Hard Sector w/Hub Ring	M54A	2.79
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5¼" DSQD Soft Sector w/Hub Ring (96 TPI)	M16A	3.79

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JUNE 1983 Vol. 54 No. 6

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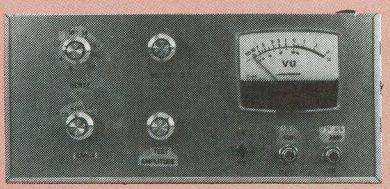
ON THE COVER

Electronic games, both video and handheld, have been extremely popular for several years now. But this past year has seen the introduction of more videogame consoles, hardware add-ons, and game software than in all previous years combined. This month, we present a special section dedicated to helping you find your way through the ever-more-confusing world of electronic games. We'll tell you what's new, what's hot, and how to get the most out of your videogame system. The section begins on page 55.



FRONT PANEL of the audio frequency-response meter. This instrument will, among other things, allow you to set your tape recorder's bias and equalization controls with extreme precision. The story starts on page 51.

COMING NEXT MONTH
On Sale June 16

- **Automotive navigation systems.** With these computer-based systems you'll never get lost again.
- **Loran-C.** A look at this fascinating low-frequency, long-range navigational system.
- **Add-on RAM.** The article on how to add 8K of non-volatile RAM to your Timex/Sinclair *1000*, bumped from this issue because of lack of space will appear in July.
- **And lots more!**

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

NEW TUBE FAMILY

Always on the iookout for features to make top-of-the-line sets more salable, TV set makers have modernized a sure-fire old approach—a change in color picture-tube size and shape. This year will see introduction of the first members of a new family of picture tubes. They'll have sharply squared corners and flatter faces, presenting a pleasing aspect in a set. Because the corners have been extended, the new tubes will be designated 14, 20, and eventually 26 inches, replacing the former 13-, 19-, and 25-inch tubes. The first such tubes will come from Japan, to be followed by American-made versions. The new size nomenclature runs head-on into a long-held superstition of American TV set manufacturers that no even-numbered tube size has ever succeeded.

ANOTHER TV STEREO SYSTEM

A novel approach to stereophonic TV sound has been demonstrated by Grumman Aerospace: Placing the L−R stereo information in the color-video signal. The new *Rainbow Sound* system transmits the L+R information through the regular TV audio channel, and samples L−R information every 21 microseconds, switching it into the video signal in the two microseconds preceding the leading edge of the horizontal sync pulse. Thus, samples of stereo information are included at the end of every line of the picture, but, according to Grumman, safely within the area that is normally overscanned in a TV set and therefore not visible to the viewer. Grumman claims that the system requires no modification to the TV transmitter, and only a minor amount of additional equipment. The system has not been submitted to the EIA Multichannel TV Sound subcommittee, which is completing tests of three more conventional stereo-sound systems.

BETAMOVIE

The second major innovation from the Beta group this year will be Betamovie, a combination video camera-recorder in a single package that uses a standard full-sized Beta cassette. Designed to look like a fairly large 8mm movie-camera, Betamovie weights just 5½ pounds and can record for up to three hours and 20 minutes on an L-830 cassette. (However, its miniaturized battery must be changed or recharged after an hour's use.) The main appeal of Betamovie will be to people who already own non-portable Beta recorders, because it is a record-only device. It will be introduced close to the year's end. No US price has been set, but it will sell for about $1,000 in Japan.

VHD VIDEODISC LAUNCHED

That on-again-off-again third videodisc system, the grooveless, capacitance-VHD type, is finally on the market—in Japan. It was formally introduced this spring by its inventor, JVC, as well as by a large number of other Japanese manufacturers. Two versions of the player are available—a deluxe type, with random access, for about $630; and one without, at around $550. A random-access accessory will be offered for the low-end model. JVC is currently the only manufacturer of discs, with an initial library of more than 100 titles.

Introduction of the VHD system in the United States, most recently scheduled for this spring, was called off because of poor economic conditions and the generally lukewarm reaction here to the two previously introduced videodisc systems. The *LaserVision* disc system is also on sale in Japan, and presumably the VHD proponents were sufficiently encouraged by its reception to make their move there. Now it appears that Europe may be the first foreign location for VHD's debut, with the U.S. still in doubt.

VCR BEST-SELLERS

RCA remains the U.S.'s No. 1 VCR brand in terms of sales, but by a considerably reduced margin, according to an annual survey made by the trade newsletter *Television Digest*. In 1982, RCA held a 22-percent market share, down from 28 percent in 1981, the survey results indicate. At the same time, the number of VCR brands on the market increased from 21 to 31. Panasonic retained the No. 2 spot, its share increasing to 17.75 percent from 15.3 percent, while Sony retained third place with a 13 percent share, down from 14.2 percent a year earlier. G.E., JVC and Zenith were in 3rd, 4th, and 5th places, respectively—all with shares of five percent or less. In 1982, VHS brands held 73.5 percent of the U.S. market, Beta 26.125 percent as compared with 7.19 percent to 27.6 percent in 1981. (The percentages add up to less than 100 because of the presence of the CVC ¼-inch tape format.) **R-E**

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Ultra lightweight stereo headphone with samarium cobalt transducer and two volume controls plus ¼" adaptor plug and extra set of ear pads. **Model 839-62**

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Super lightweight dynamic stereo headphone with ¼" adaptor plug and extra set of ear pads. **Model 839-61**

Super lightweight stereo headphone with ¼" adaptor plug and extra set of ear pads. **Model 839-58**

Innerphone microstereo headphone with ¼" adaptor plug and extra set of ear pads. **Model 839-57** (not shown)

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WHAT'S NEWS

Growing computer field faces growing pains

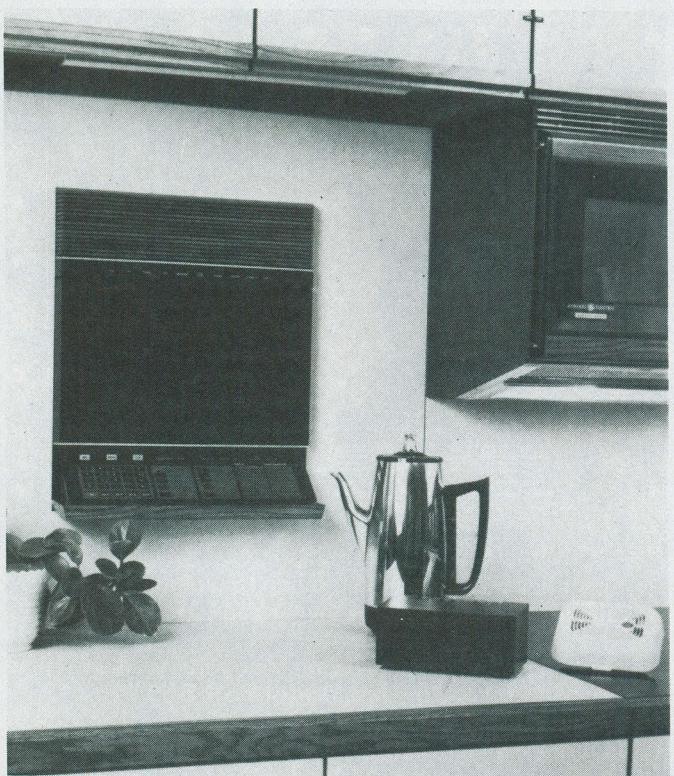
Lack of communication between computers is one of the more serious problems in the expanding small-computer field, George Morrow of Morrow Designs told the recent Automated Office Conference in San Francisco. "Until local networking comes of age," he told the conference, "carrying a floppy disk from one computer to another is the most effective way to transfer information." The problem is made even more confusing, he said, by the lack of an accepted networking standard.

A second problem is that software has not kept up with hardware in terms of productivity improvement. "Hardware costs have come way down in recent years," he said, "but there's been no real change in programmer productivity since compilers were developed in the 1950's."

A partial solution is the "universal" software package, that can run in a wide variety of hardware environments. The package increases productivity because the programmer "doesn't have to reinvent the wheel for each individual machine."

Universal software has also led to another development—bundling software with hardware, said Morrow, citing his own company's introduction of the *Micro Decision* personal/business computer in 1982. It was supplied with six software packages, including word processing, a financial spreadsheet, and a spelling checker; it sold for $1,590, which Morrow said is less than the cost of the software alone.

HOME CONTROL/SECURITY SYSTEM



A "PHONE-HOME" CONTROL SYSTEM, UNVEILED BY GE LAST JANUARY at Las Vegas, will allow homeowners to phone home to control appliances remotely. A simple phone call can monitor or control heating and cooking systems, kitchen appliances, lighting, security and smoke alarms, and phone-message devices. It also notifies the proper authorities automatically in case of break-in or fire when nobody is home, then dials a pre-set number where the homeowner can be reached and delivers the message by synthesized voice.

Tesla coil construction gaining new interest

Before audio arrived to attract the experimenter's attention, practically every electrics enthusiast had or was preparing to build a Tesla coil. Now interest is surging again; a group—The Tesla Coil Builders Association—formed in July, 1982 is already approaching 200 members strong.

Started by Harry Goldman of Glens Falls, NY, the new association puts out a quarterly publication, *T.C.B.A. News*, that runs from 8 to 18 pages per issue. It contains descriptions of coils built by members; reprints of old articles (some dating back to Hugo Gernsback's *Electrical Experimenter*) on building coils; technical articles on Tesla coil theory; experiments with high frequencies, and even news items on large Tesla coils accessible to visitors in museums or observatories.

Information about the Association may be obtained by sending a *stamped,* self-addressed envelope (absolutely a must!) to Harry Goldman, RD 3, Box 181, Glens Falls, NY 12801.

Fujitsu to build plant in Southwest U.S.A.

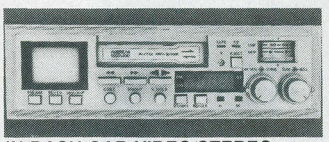
Fujitsu America Inc. (FAI) is planning a U.S. facility to manufacture optical-fiber communications systems and related equiipment. Present plans call for a 38,000-square-foot structure in the Southwestern sunbelt region; the structure is to be completed by the end of 1983.

The plant is expected to employ approximately 150 workers in the production, assembly, and testing of optical-fiber equipment. Fujitsu hopes to achieve an annual production volume of $100 million in the new facility.

In-dash TV for your car

Claimed to be "the world's first compact in-dash car video," the American Audio Corporation's *ET-9000TV* features black-and-white TV, as well as an AM-FM stereo radio, an auto-reverse stereo cassette-player, and a digital quartz clock.

The unit is designed for safe driving—when installed in the dash, the picture tube is blacked out when the ignition switch is "on;" the TV sound continues, however. If it's installed in the rear of the car, the equipment may be wired for TV viewing while the car is running.



IN-DASH CAR VIDEO/STEREO.

The system has a nominal output of 18-watts RMS per channel (maximum 25 watts per channel) and carries a suggested retail price of $1,495.

New picture-tube unit for RCA and G.E.

A new color-tube concept developed by RCA, COTY-29, will be produced by that company as well as General Electric and Zenith. COTY-29 stands for *C*ombined *O*ptimum *T*ube and *Y*oke in a *29*-millimeter neck. The RCA tube uses a system in which all elements—yoke, tube, and receiver—have been optimized for reduced system cost, plus improved performance and reliability.

The new system is expected to minimize manufacturing costs for color-TV receivers, chiefly because of a substantial reduction in yoke size. It can be used on all tubes from 13-inch to 25-inch, and with 90-degree through 110-degree deflection angles.

RCA will begin production of COTY-29 picture tubes later in 1983, with G.E. and Zenith expected to follow soon after.

Radio pioneer enters Inventors Hall of Fame

Ernst F.W. Alexanderson, developer of the high-frequency alternator that made trans-Atlantic communication practical, has been inducted into the National Inventors Hall of Fame in Arlington,

continued on page 8

TEK 2200 MULTI-PURPOSE OSCILLOSCOPES

THE PERFORMANCE/ PRICE STANDARD

Now. Tektronix 60 MHz Performance is just a free phone call away!

Wide-range vertical sensitivity: Scale factors from 100 V/div (10X probe) to 2 mV/div (1X probe). Accurate to ±3%. Ac or dc coupling.

Two high-sensitivity channels: dc to 60 MHz bandwidth from 10 V/div to 20 mV/div; extended sensitivity of 2 mV/div at > 50 MHz.

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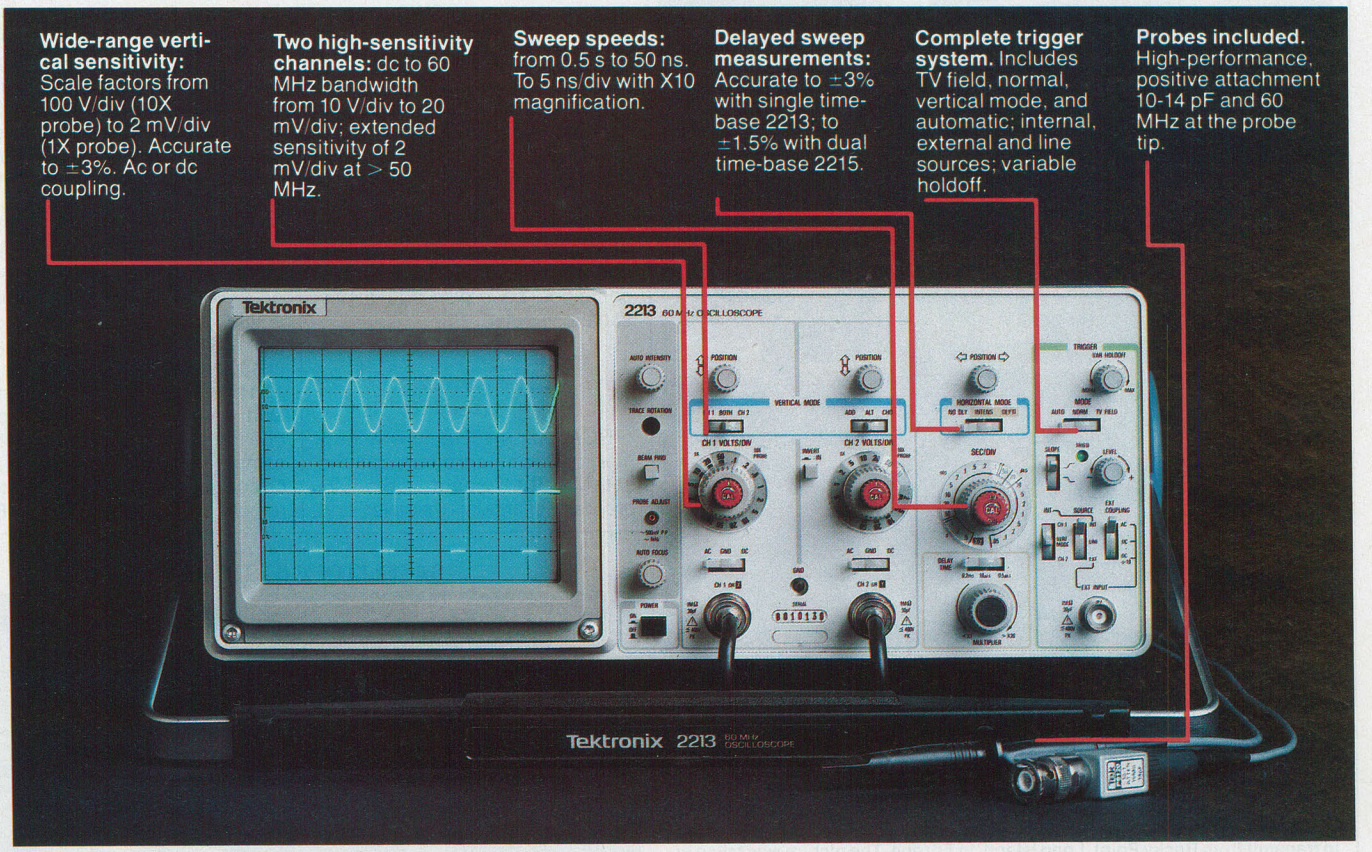
Complete trigger system. Includes TV field, normal, vertical mode, and automatic; internal, external and line sources; variable holdoff.

Probes included. High-performance, positive attachment 10-14 pF and 60 MHz at the probe tip.



These easy to order scopes are proof that it's not expensive to have advanced, 60 MHz performance from Tektronix on your bench. It's just practical! Feature for feature, the Tek 2213 and 2215 set a price/performance standard unmatched among portable scopes. And are backed by the industry's first three-year warranty on all labor and parts, including the CRT.

So advanced they cost you less: $1200* for the 2213! $1450* for the dual time base 2215! These low costs are the result of a new design concept that utilizes fewer mechanical parts than any other scope.

Yet there's no scrimping on performance and reliability. You have the bandwidth for digital and analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements.

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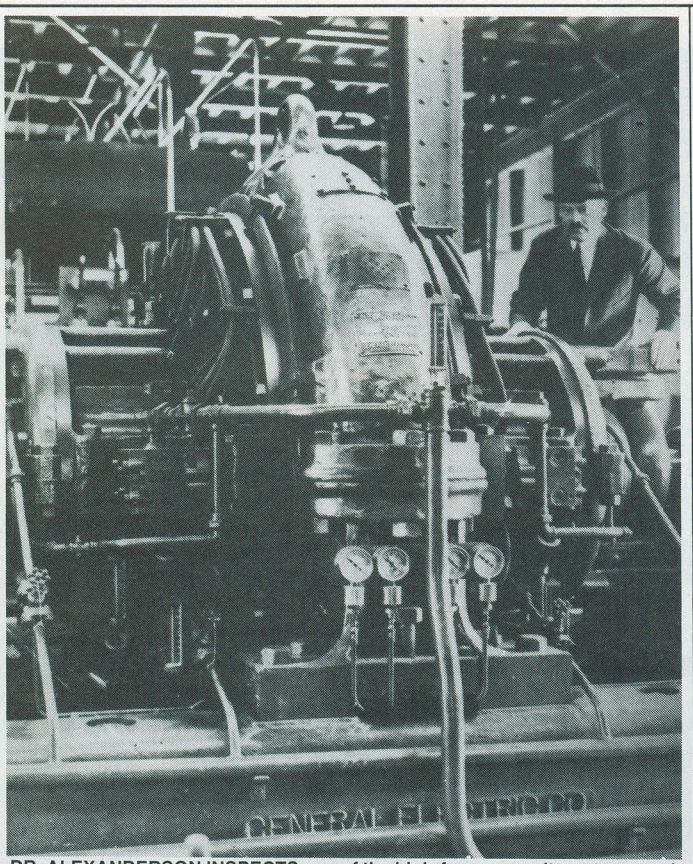
WHAT'S NEWS

continued from page 6



DR. ALEXANDERSON INSPECTS one of the high-frequency alternators used to transmit from Rocky Point, Long Island, to Europe. The picture was taken in 1922.

VA. At the induction ceremony, the U.S. Commissioner of Patents dedicated an exhibit and presented a plaque to his widow, Mrs. Thyra Alexanderson.

The alternator displaced spark and the arc in high-power communications and ruled the airwaves until tube transmitters were developed.

Dr. Alexanderson was a pioneer in other fields. In 1924 he transmitted the first facsimile message across the Atlantic. In 1927 he staged the first test of home-TV reception (using high-frequency neon lamps and a perforated scanning disc) at his own home in Schenectady, NY.

He was also a pioneer and early inventor and designer in high-voltage power transmission. In all he obtained 322 patents during his long career with General Electric, making him the company's most prolific inventor.

This honor is by no means Dr. Alexanderson's first. He has received many, including the Gold Medal of the Institute of Radio Engineers in 1919, The Edison Medal from the American Institute of Electrical Engineers in 1944, and the Royal Danish Medal in 1946.

Sound with still pix on Pioneer Laserdisc

Pioneer has announced a still picture with sound (SWS) system. When their *Laserdisc* is so operated, it is able to store an almost unbelievable amount of program content.

Normally, 54,000 still pictures to the side can be recorded on a *Laserdisc*. To permit sound to be recorded also, the number of pictures is cut to 5400 and sound is recorded between each picture—using voice-compression techniques. Connected to a TV or monitor through an SWS adapter, each voice recording plays 13 seconds. Total playing time is 20 hours.

New applications, such as new product presentations, travel guides, language lessons, catalogs, and others are expected with the new system.

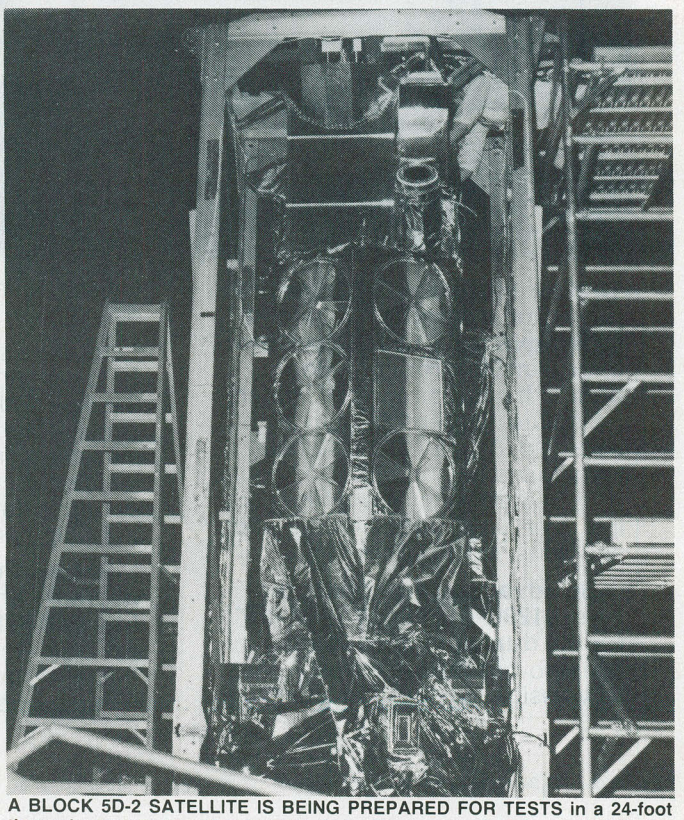
Pioneer has also announced the development of a conversational interactive system. The system combines *Laserdisc* and a personal computer.

New K-band satellite to improve home TV

RCA plans to launch a new higher-power communications satellite that would make TV-program distribution simpler and cheaper. As described by Eugene F. Murphy, President of RCA Communications Inc., it would contribute significantly to the expansion of existing markets and the development of new services such as Satellite Master Antenna Television (SMATV) systems. The proposed satellite will have an output of 40 watts in the K-band (10.9 to 36 GHz).

SMATV is a service used to distribute television from a receive-only antenna to points within a single building or building complex. Smaller antennas, made possible by the higher frequency and power of the K-band transmission, can be located on rooftops, offering substantial savings when compared to terrestrial microwave or coaxial cable connections to a remote antenna location. **R-E**

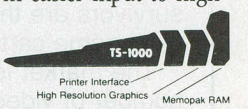
SATELLITE GETS TESTS



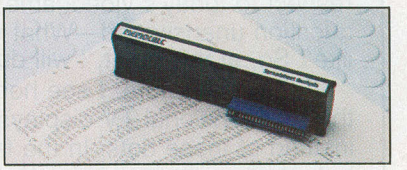
A BLOCK 5D-2 SATELLITE IS BEING PREPARED FOR TESTS in a 24-foot thermal vacuum chamber at RCA Astro-Electronics in Princeton, NJ. The chamber is designed to simulate the conditions to which the satellite will be subjected in outer space. The Block 5-D satellites are designed and built for the U.S. Air Force Space Division. The first of them was launched last December 20, and is now operating in the Air Force Defence Meteorological Satellite Program system.

TIMEX MAKES THE COMPUTER, BUT WE MAKE IT TICK.

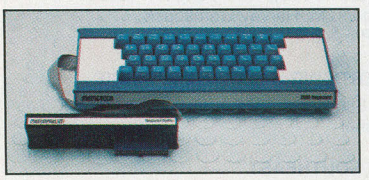
If you own a TS-1000 or ZX-81 computer and want to bring out the power within it, you'll want Memotech. From easier input to high quality output and greater memory, Memotech makes the add-ons you demand. Every Memotech peripheral comes in a black anodized aluminum case and is designed to fit together in "piggy back" fashion enabling you to continue to add on and still keep an integrated system look.



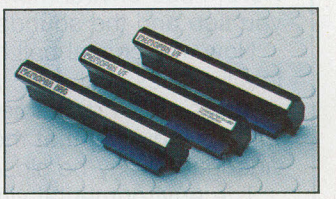
MEMOPAK RAM All Memopak RAMs are directly addressable, user transparent, are neither switched nor paged and no additional power supply is required. You can also choose the Memopak RAM which is just right for your needs. From economy to power. **16K RAM** The Memopak 16K RAM is the most economical way to add memory to your TS-1000. It is fully compatible with the Timex or Memotech 16K RAMs to provide you with up to 32K of RAM. The 16K RAM also offers additional add-on capabilities through its "piggy back" connection. **32K RAM** The 322K Memopak enables you to execute sophisticated programs and store large data bases and like the 16K RAM is fully compatible with Timex's or Memotech's 16K RAMs to give you a full 48K of RAM. **64K RAM** The 64K Memopak is powerful enough to turn your TS-1000 into a computer with capabilities suitable for business and educational use. It accepts such BASIC commands as 10 DIM A (9000). **MEMOCALC** Memocalc, our spreadsheet analysis software, enables TS-1000 users to perform complex number crunching routines with ease. With the 64K RAM a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Quick revisions can be achieved by entering new data to your formula.



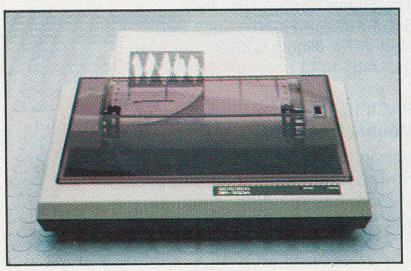
MEMOTECH KEYBOARD For ease of operation, the Memotech keyboard is a high quality standard typewriter keyboard, with TS-1000 legends. The keyboard is cable connected to a buffered interface which is housed in a standard Memopak case and plugs directly into the back of the TS-1000 or other Memopaks. **MEMOPAK HRG** The Memopak High Resolution Graphics, with up to 192 by 248 pixel resolution, enables display of high resolution "arcade game" style graphics through its resident 2K EPROM, programmed with a full range of graphics subroutines.



CENTRONICS PARALLEL AND RS232 INTERFACES Memotech's Interfaces enable your TS-1000 to use a wide range of compatible printers. The resident software in the units gives the complete ASCII set of characters. Both Memopak Interfaces provide lower case character capabilities and up to 80 column printing. The RS232 Interface is also compatible with modems and terminals.



SEIKOSHA GP 100A PRINTER The Seikosha GP 100A uses a 5x7 dot matrix printing format with ASCII standard upper and lower case character set. Printing speed is 30 characters/second with a maximum width of 80 characters. The printer uses standard fanfold paper up to 9-1/2 inches wide. The GP 100A is offered as a package including cable and interface. Other printer packages are also available through Memotech.



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Centronics Parallel Interface	74.95		
RS232 Interface	99.95		
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GP 100A Printer Package**	399.00		
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EDITORIAL

Videogames Today And Tomorrow

Videogames have come a long way since Atari's original *Pong*. Many videogame manufacturers have come and gone. Many more videogame systems have disappeared. In today's market, the survivors are the cartridge-programmable videogames and videogame cartridge manufacturers.

The market for videogame cartridges has exploded and the number of videogame cartridges and cartridge manufacturers is growing at an unbelievable pace. Hardly a day goes by when a new videogame cartridge or accessory is not announced. To illustrate this point, this year's summer CES show (which will be held in early June) will devote a large block of exhibition space exclusively to videogames. Keeping track of the new videogame cartridges as well as the new videogame accessories is a difficult task. To keep our readers abreast of this market, this issue presents a special section devoted to videogames. Handheld and tabletop games are also covered.

While our special videogame section will bring you up-to-date with respect to today's videogame market, it does leave one major question unanswered—What will the videogames of the future look like? So, at this point, I will dust off my crystal ball and gaze into it.

In the near future, I see home videogames with true three-dimensional TV displays. *Pac-Man* will try to gobble you up instead of those dots. In the far future, I see home videogames using holographic displays instead of TV sets. *Pac-Man* will now have the ability to attack you from all directions.

In the future, the arcade videogames will also change radically. Here, I see environmental videogames. These will control the images you see and the sounds you hear, and what you feel.

Now, my crystal ball has served me pretty well. But, I have to be totally honest with you. Atari has expressed interest in a system that displays true three-dimensional images on a standard TV receiver without requiring that the viewer wear special glasses. So, the 3D videogame may be closer than we all think.

The environmental videogame is currently being test-marketed. For approximately two dollars in change, the player climbs into a spherical vessel. Once inside, the player is strapped in and is surrounded by video displays. When the game starts, the sphere lifts-off and rides atop a column of air. By controlling the airstream, the player controls the position of the sphere. Inside the sphere, the video screen places the player at the controls of a starship that is hunting enemy starships. Of course, the object of the game is to destroy all the enemy starships.

Initially, the environmental videogame has been well received. There is one drawback, however. The first few times someone new plays this videogame, he finds himself so overwhelmed with the ability to control the attitude of the sphere that he forgets to play.

So, now that I've taken the credit away from my crystal ball I'll let you enjoy our special videogame section.

ART KLEIMAN
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MICROPROCESSORS:
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8-bit: 8085

DISK STORAGE:
Built-in standard 5.25" disk drive, 320K bytes/disk

KEYBOARD:
Typewriter-style, 108 keys, 13 function keys, 18-key numeric pad

GRAPHICS:
Always in graphics mode. 640h/225v resolution; up to eight colors are available**

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Two RS-232C Serial Interface Ports and one parallel port

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AVAILABLE SOFTWARE:
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CP/M-85
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Most standard 8-bit CP/M Software

*128K bytes standard.
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The H-100 is easy to build – the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge – "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.†

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Dual microprocessors for power and compatibility. The H-100 handles both high-performance 16-bit software and most current Heath/Zenith 8-bit software.

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And the industry-standard S-100 card slots support memory expansion and additional peripheral devices, increasing future upgradability of the H-100.

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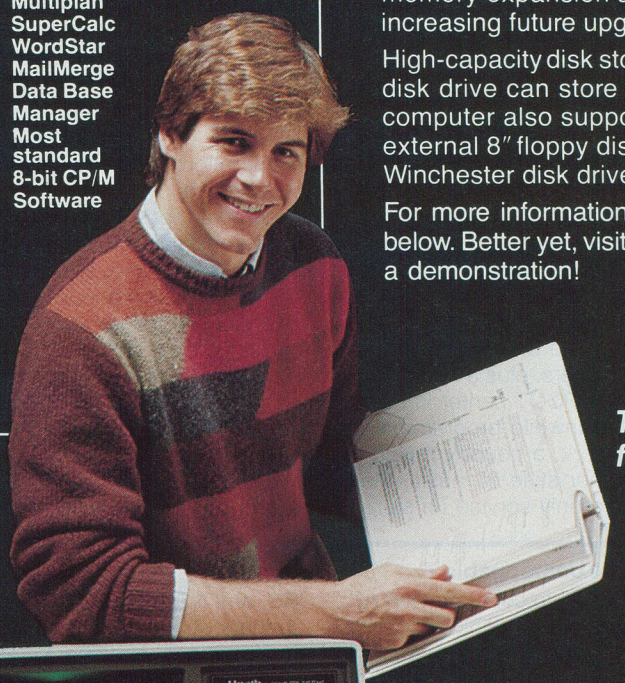
For more information, circle the reader service number below. Better yet, visit your Heathkit Electronic Center for a demonstration!



The H-100 gives me the most for my computer dollar!

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CIRCLE 16 ON FREE INFORMATION CARD

SATELLITE/TELETEXT NEWS

SPACE SETS LICENSING ACCORD WITH SELECTV

A landmark agreement involving authorized transmission of pay-TV programming to private satellite receivers has been hammered out by SPACE (The Society for Private and Commercial Earth Stations) and SelecTV, a California-based subscription-television service which transmits up to 90 programs per month. The agreement covers satellite delivery of movies to residents of multi-unit dwellings and distinguishes SelecTV as the first premium service to go after the private cable and SMATV (*S*atellite *M*aster *A*ntenna *TV*) market. The agreement provides for attractive volume discounts and rates for the pay-TV service, depending on the number of subscribers delivered through the SPACE member companies.

The agreement comes at a time when other major program suppliers, such as Home Box Office, decline to bargain with the growing number of SMATV system operators who want to offer pay programming directly to apartment, condo, and mobile home dwellers. The SPACE-SelecTV deal involves a sliding fee scale under which SMATV operators pay about $7 per subscriber (less for high quantities) for use of the SelecTV programming.

TOO MUCH OF A GOOD THING?

The continuing increase in satellit programming was expected to reach a saturation point; for years, gloomy forecasters have predicted that the cable industry couldn't absorb all the programming being sent its way via the new satellite networks. The predictions began coming true in recent months, starting with the demise of CBS Cable, the critically acclaimed cultural channel, which ceased operations at the end of last year. The Entertainment Channel, a joint venture of RCA and Rockerfeller Center, was another attempt at a cultural-programming channel. Although it is no longer in operation, don't count it out yet. It is expected to be back again, this time as an ad-supported service.

Within a few days of the announcement that CBS would close, Group W Satellite Communications and Walt Disney Productions said they were dropping their joint venture to launch a "Disney Channel" pay-TV kidvid service. But Disney is going ti alone, and still intends to begin transmitting the channel, probably aboard a Westar bird; target start-up date was April 11. About one-third of the channel's programs will come from the Disney library of animated and live-action films; the rest will be children/family shows acquired from other producers, plus a healthy dose of original programming created in connection with Disney's new EPCOT center in Florida.

Meanwhile programming services continue to bloom. Over at Group W, the Nashville Network, a country music channel transmitted via Westar, has taken shape. For fans of another style of music, the recently launched Cable Jazz Network offers 24-hours-a-day audio-only service (in stereo) aboard the CBN Cable Net I transponder.

AROUND THE SATELLITE CIRCUIT

The unstoppable Ted Turner is making noises again—this time about launching a "fourth network" to compete with ABC, CBS, and NBC as a full-scale national broadcasting effort. The network would try to line up independent TV stations, plus disenchanted affiliates of current networks. Programming would primarily encompass original shows, although other Turner subsidiaries—especially Cable News Network—would contribute to the program lineup. Target launch date could be as early as this fall, and the tentative name is Turner Network Television—or "TNT."

The Canadian government is cracking down on unauthorized satellite receivers. A new enforcement project, coordinated by the government's Department of Communications, has started with warning letters sent to unlicensed users. The main targets are unauthorized cable and SMATV operators, such as apartment complexes or saloons which pull in programming from U.S. cable birds. At this time, the government doesn't plan to go after home or private users of earth stations—a difficult task, anyhow, in Canada's wide-open spaces.

Scientific Atlanta has introduced a line of receive-only earth stations—the Series 9000 models—which are available in 2.8-meter and 3.2-meter designs, starting at $1,500. They replace a costlier line of professional equipment for mini-cable and SMATV operations.

Canada and the U.S. have set up an arrangement which will allow satellite communications companies in both countries to negotiate agreements with each other for use of domestic satellites to carry communications to the other country. Until now, all telecommunications traffic between the U.S. and Canada were carried by terrestrial microwave facilities, with occasional satellite transmission permitted in accordance with a 1972 arrangement between the countries.

VIC-20

(a real computer at the price of a toy)

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(more power than Apple II at half the price)

$89.00

(when you buy 6 programs)

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33K COMMODORE VIC $159.00
with 2½ times more power

You get the VIC-20 computer plus we expand the total memory to 33,000 bytes to give you 2½ times more programming power.

41K COMMODORE VIC $199.00
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VIC20 PERSONAL COMPUTER

TOP 10 ARCADE GAMES

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4.	Snackman (Better than Packman)	$15.95
5.	Galactic Crossfire (you in the middle)	$16.95
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7.	Bug Blast (Creepy)	$16.95
8.	Bombs Away (Great)	$15.95
9.	3-D Maze-Escape	$14.95
10.	Krazy Kong	$14.95

BUY ANY FOUR — DEDUCT 10% MORE

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Commodore 64 Computer

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80 column BOARD

80 characters per line on the screen at one time. Includes word processing pack (list $89.00), complete data base pack (list $89.00), Electronic spreadsheet pack (list $89.00). **ALL FOR ONLY $179**

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COMMODORE-64 PROGRAMMERS REFERENCE GUIDE

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VIDEOGAMES

Game or computer?

DANNY GOODMAN, CONTRIBUTING EDITOR

IT APPEARS THAT AFTER MANY YEARS OF promises, we will really have keyboard expanders and computer functions for several game systems this year (see this month's special section for reports on what's in the works from Atari, Coleco, Mattel, and Odyssey). But that development is forcing many videogame enthusiasts to face a difficult decision—whether to buy one of the many under-$300 computers currently on the market, or to upgrade their present videogame with one of the new add-ons, such as the one from Mattel, shown in Fig. 1.

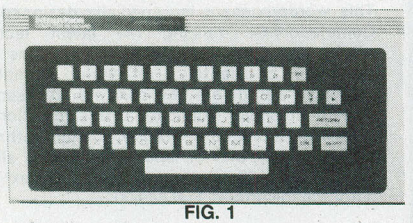

FIG. 1

Computers are a tempting alternative; they're amazingly versatile, and they also offer the promise of helping children and adults prepare for the "World of Tomorrow" (a phrase whose meaning may be obsolete in only a few years). As productivity tools, computers are hard to beat. With a computer system and word-processing software you can shuffle more words in a year and a half than you could have in four years with your the old typewriter.

But what about games? There are, of course, games for just about every computer on the market. Some are quite good, especially those using high-resolution color graphics. But it's unlikely that you'll be able to find a single computer that is capable of playing all of your favorite videogames. Where else but on a game system can you play such a wide assortment of popular arcade, space-action, adventure, and strategy games? And even if some company such as Activision should decide to come out with a computer version of *Pitfall*, how long will you have to wait for it? And will you have the right computer to play it on?

The fact is that the majority of the top-quality games today are coming from the home videogame-software companies—that's their business. To remain on top of a very competitive marketplace, those companies are dedicated to recruiting the best game-design talent and producing more of the kind of games we want to play. And since there are more videogames out there than there are computers, and in far fewer formats, companies find it much easier, and more profitable, to supply that market. Finally, even the differences in format have begun to disappear with the introduction of adapters that allow you to play one system's cartridges on another. That's something you're unlikely to see in the computer market.

Another new development is the introduction of game-hardware add-ons—voice modules, for example—that greatly enhance game play. While such add-ons are also available for computers, at least to some extent, most computer-game software is not configured to take advantage of them. Also remember that to be as versatile as it is, a computer must make compromises along the way. Those compromises become obvious when a computer is compared to a "dedicated" machine, whether it be a videogame or a word processor.

"But," you may object, "you can do so much more with a computer!" Indeed you can. Keep in mind, however, that compromise is the key word here. If you buy a computer to play games now and expand later, what is likely to happen is that you will eventually discover that your machine is not suited to many serious computer-applications. Thus, if you have a specific application in mind (telecommunications, data management, business graphics, electronic spreadsheets, or word processing), buy a computer for it. If the computer has a few games available, then all the better for you.

But if you want to play video games now and expand later, direct your attention to today's videogame systems. You'll have an immediate quality library to choose from, plenty of new titles to look forward to, plus, on most machines today, the ability to add some measure of computer capability. In most cases it will be a simple computer add-on, but it will supply you with a fundamental knowledge of personal computing. Armed with that knowledge, you'll be able to select the proper, practical, personal computer to fulfill your needs. And you won't have wasted your money on a weak computer that doesn't even do a good job of game playing.

Contrary to what some analysts believe, there is room for both industries in the consumer marketplace.

Starpath's Dragonstomper for Atari 2600

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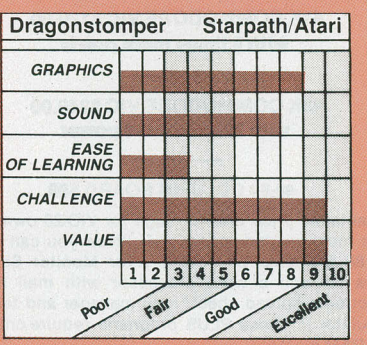

Like most of Starpath's cassette-tape games for the Atari *2600*, which require the Starpath *Supercharger* plug-in module and a cassette-tape player, *Dragonstomper* will be admired more by experienced joystick jockeys than by casual game players. It is not a game with which to kill a few minutes before dinner. But if you are into adventure gaming, you owe it to yourself to see how a devilishly complex game can be properly executed for the *2600*.

Dragonstomper is a multi-load game. That is, the entire game requires three tape loads to complete.

The ultimate goal of the game is to capture a magic ring guarded by a fierce dragon. To get to that final stage, however, you must first acquire enough gold and other possessions in the wide open country to get past a guard at the bridge to the city. You begin the game with some gold, strength, and dexterity. As you wander through a territory covering about nine

continued on page 21

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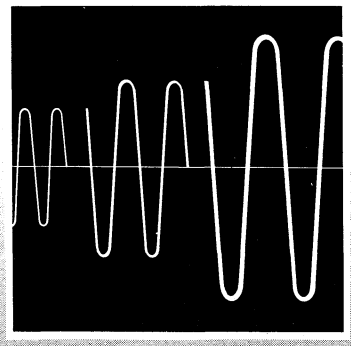

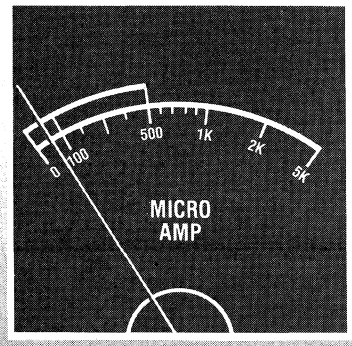

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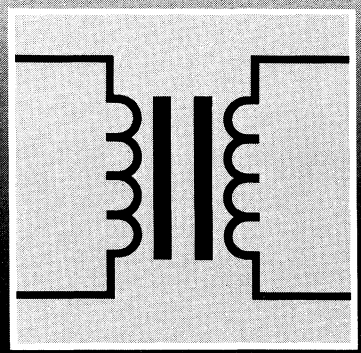

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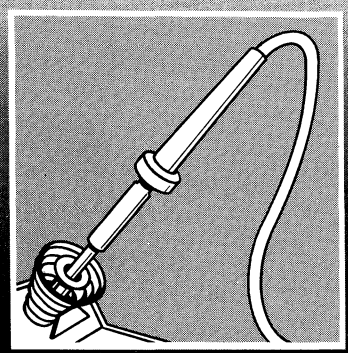

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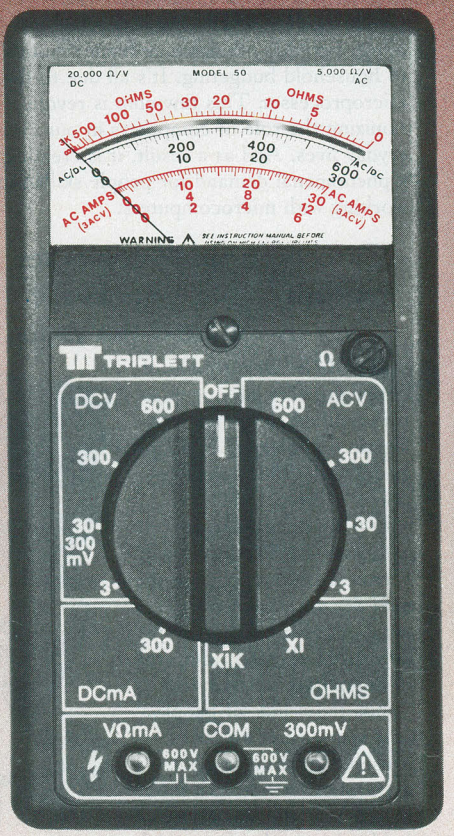

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VIDEOGAMES

continued from page 14

consecutive screens, you'll come across a random selection of eleven different foes. Through the clever design of screen prompting messages and joystick responses, you can elect to fight any enemy, although doing so may cost you some strength. But a victory may net you a prize and/or gold. Keys can open doors to locked temples, huts, churches, and castles on the screen. Using some possessions helps you regain strength.

Once you've gotten past the guard, the second load puts you in a one-screen city with three shops and three warriors. As you enter each, the screen changes to the inside of the shop, where, through a shopkeeper, you can sell off possessions and buy new supplies for your journey to, and battle with, the dragon. You can also enlist any or all warriors for your battle. When you're ready, you go to a gateway to the darkness—and the third load.

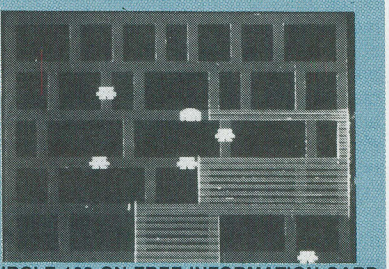
That load features a corridor laden with visible and invisible hazards that scrolls vertically as you inch your way along. Your strength and dexterity are sapped, requiring judicious use of certain supplies to replenish them. After a region of poison darts comes a pit—your entrance to the dragon's room and the magic ring vault. Getting by the dragon is an incredible challenge. And reaching the ring rewards you with a magnificent color display and heroic music.

If the descriptions here are vague, they are purposely so. The fun of *Dragonstomper* is in discovering the effects of the dozens of possessions and supplies at your disposal throughout the game. The instructions won't help, so be prepared for long sessions and experimentation.

The *Supercharger's* graphic power comes through in the prompting and inventory messages, as well as fine touches in numerous screen elements. You would need two or three $35 game cartridges to achieve the complexity of this one $18 tape (plus $44.95 for the *Supercharger* module). But even then, you wouldn't have the same continuity, because the game carries over inventories from one load to the next.

You'll work hard in this game. And even after you reach the magic ring once, you'll still want to experiment again with other powers and possessions. If you think you're an adventure pro, you can prove it by telling me the title of the heroic tune at game's end.

Parker Brothers' Amidar for Atari 2600



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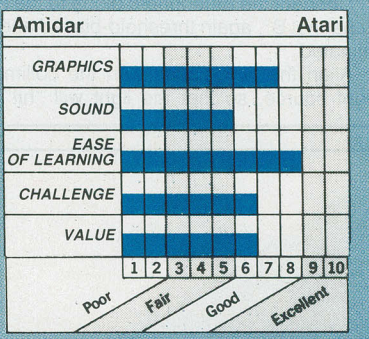

Parker Brothers won over many converts with its first arcade-game title, *Frogger*. That was one of the truest-to-arcade adaptations ever developed for the *2600*. Unfortunately, its second arcade attempt, *Amidar*, leaves out much of the flavor of the arcade game on which it is based. What comes through, however, is a maze-type game for your library with unusual play characteristics.

Amidar was not a rip-roaring success in the arcades, so it's possible you may not have played the original for comparison. The essential scenario of Parker's one-player, two-screen home version is the same. On the first screen, you are in control of a gorilla, who is being chased by five warriors. All characters move only on the horizontal and vertical bars. As the gorilla moves, he leaves a trail of color behind him. If he colors all four sides of a square, the interior of the square fills. The goal, then, is to fill all the squares without being touched by the warriors.

Your gorilla has a couple tricks up his hairy sleeve, however. For each gorilla "life," you have up to four opportunities to make the warriors invisible for a few seconds and thus escape a sandwich situation (warriors also move faster than the gorilla, so they may overtake you in a straightaway). Additionally, if your gorilla manages to color all four corner boxes, the warriors turn into chickens and the gorilla can get bonus points for intercepting them. After about five seconds and warning sounds, the chickens again become warriors and pursue your gorilla.

Screen two is an identical maze, only this time you control a paint roller, while five pigs chase you; they look like tiny piggy banks in this version. The objective is the same on this screen—color the maze. (The difficulty level is the same—it increases only after every gorilla – paint-roller round.) Successful completion starts you back on the first screen with six faster warriors.

What I don't see from the arcade version is the gorilla picking up coconuts along the maze in screen one. In the second screen of the arcade version, the roller turns ninety degrees for horizontal painting—no such luck in the home version, because of the limited capabilities of the *2600*. Also, in the arcade version the paint roller screen is a lot tougher, because only blank squares adjacent to colored squares can be painted; the paint has to roll continuously around a square instead of leaving the haphazard trails that were permissible in the first screen. Parker's *Amidar*, however, is not so sophisticated.

To the game's credit, I get frustrated sometimes when I've colored the fourth corner under pressure from the warriors. I expect an instantaneous switch from warrior to chicken, but there is often a delay of a second or so—disastrous for my poor gorilla. Yet on other occasions, squares fill in immediately.

Pattern players will find the gorilla/roller's foes easy to track, relegating the game to the *Pac-Man* genre. The game's graphics are crisp for the *2600* and free from the serious Atari *Pac-Man*-cartridge flicker problems, even though there are more moving objects on the screen. The sound, however, is somewhat dull, particularly compared with the subtle, tension-building background music of the original.

Amidar may be fine for a light action game, but don't expect the glitter of an arcade jewel. **R-E**

LETTERS

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FASTER THAN LIGHT?

In the January 1983 issue of **Radio-Electronics,** Dr. Harold W. Milnes claims that his experiments have shown that electric waves move over wire with velocities exceeding *c*—the speed of light.

It is not my purpose here to argue about the theoretical aspects of his article; neither will I take the space to show some flawed assumptions—such as the negligence of the inductions of his giant loop, etc.

If we want to compare the velocity of light propagation *c* with the velocity of propagation of an electrical wavefront along a wire or a transmission line, then an experimental arrangement should be—and can be—devised to let the one "race" against the other.

A most appropriate experimental setup—which, I agree, cannot be devised on the cheap—is to initiate an electrical wave as a result of a light wave.

Needed equipment (and that is where the cost comes in): A collimated light source with remote control over a shielded wire by means of a pushbutton switch; a straight stretch of twin lead (300 ohm) transmission about 100 meters long; two photodiodes—with identical characteristics (no photo transistors—they are too slow for the experiment); appropriate biasing battereis and "pots" for the diodes—also 300-ohm termination resistances for each diode. Now, the most expensive item: a two-channel, high-frequency scope with "storage" feature.

The setup: Connect the 300-ohm terminated transmission line to "channel A" of the scope with one photo diode at the "far end" (properly biased to threshold forward conduction).

Connect the other photo diode to the input "channel B", again threshold-biased and terminated.

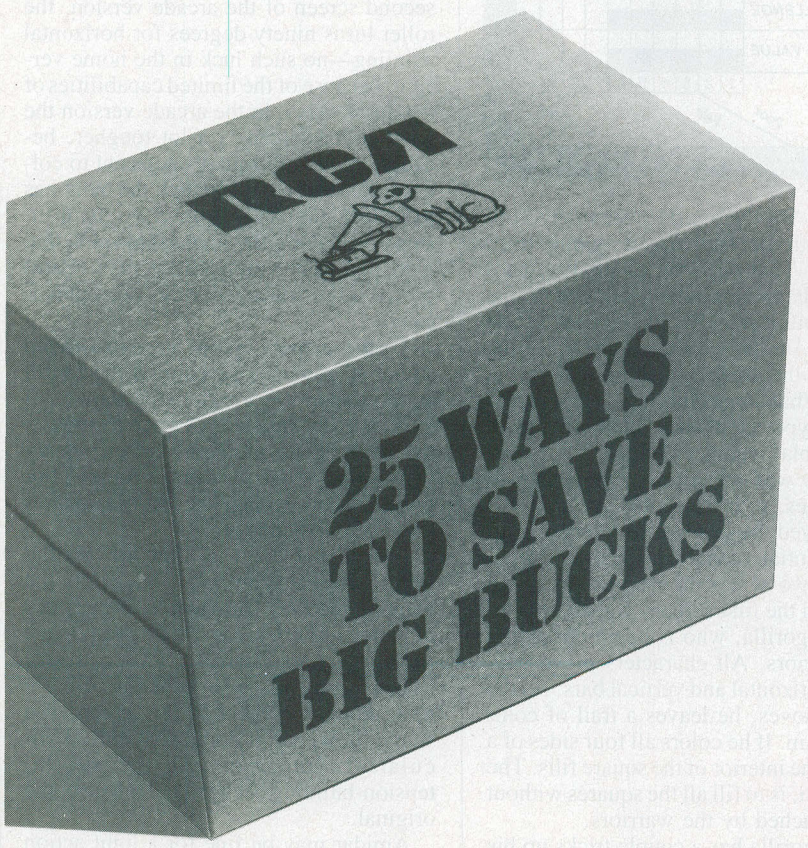
Align the two diodes with the collimated light source, so that the light will "hit" the diode of channel A first. Use the pushbutton also to trigger off the horizontal sweep of the scope.

Incidentally, to be able to distinguish the output of the two diodes, one might like to have the one connected in the opposite-polarity sense with respect to the other. That is easy, because we have two independent bias batteries.

After proper arrangements are made, take care that no stray light hits either diode. (Wait until dark, for example.)

Now, the experiment: Push the button briefly to obtain a light flash. The light wavefront will hit the "far" diode first and then the one of channel B about ⅓ microsecond later. The electrical wave front set off by the first photo diode meanwhile has traveled the distance toward the scope, but along wire. The position difference between the two vertical lines of the scope will tell you which one traveled faster than the other.

The possible delay between light and con-



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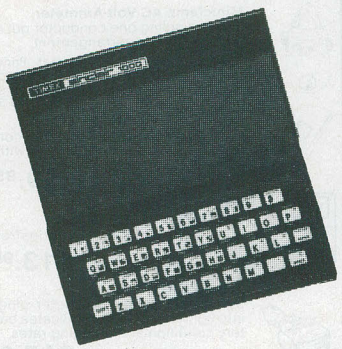

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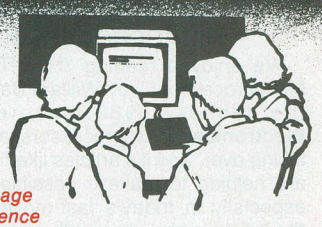

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ductance in each diode is small, but since both diodes are identical, the experiment will just cancel that possible excuse out and be totally honest. Incidentally, good photodiodes are made by many first-class semiconductor houses: There is Motorola's MRD500 or Hewlett Packard's HP4220.

If all that is a little too expensive for your taste, there is a less comprehensive way of testing the theory: Take a crystal-controlled 10-MHz generator (pure sinewave is required) and launch a standing wave on about 120 meters of transmission line by having first an open line and then a shorted line. With a very loosely coupled detector, count the number of minima (nulls). You should find two nulls per wavelength.

Since $\lambda = v/F$, you can verify for yourself whether v is smaller, equal to, or larger than *s*. If the number of nulls along the 120-meter stretch is *less* than eight, v would have to be larger than *c*. Good Luck!

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MICROPROCESSORS

We enjoyed reading "How To Interface Microprocessors," by William Barden, Jr., in the January 1983 issue of **Radio-Electronics.** Microprocessors are, indeed, taking over, and it's articles like that one that are helping to make it possible. However, especially in today's fast-moving world of the article is already slightly obsolete in what it refers to as "state-of-the-art."

Specifically, Fig. 7 (two 7475 latches and Fig 8 (four 75451 relay drivers with eight discrete diodes) can all be replaced directly with a *single* Sprague UCN-4801A BiMOS latched driver. That single integrated circuit also features improved output ratings (50 volts and 500 mA).

Alternatively, if even higher output ratings are required, the 75451 drivers and diodes can be replaced with a single device from the Series ULN-2820A for ratings to 95 volts, or with two devices from the Series UDN-2540B for rating to 1.5 A.

F. RAYMOND DEWEY
Worcestor, MA

COVER TESTER

I don't know who was using the IC tester on the cover of your January 1983 issue, but he obviously doesn't know one end of an IC from the other.

STEVE HATLEY
Jonesboro, TN

Our cover photographer was using the IC Tester. And you're right—he doesn't.—Editor

HOME-STUDY COURSES

Readers of **Radio-Electronics** may be interested in knowing about two new "study-at-home" courses that are now available from Oklahoma State University. They were developed by Dr. Larry Jones, professor of electronics-engineering technology, and are designed for students who have a basic understanding of electronics. They go on to introduce students to theories needed to understand and implement specific applications using the technology.

The courses, "Digital Electronics" and "An Introduction to Linear Integrated Circuits" are each offered for three hours of university credit from the Oklahoma school. Admission requirements apply *only* to students who are working toward an OSU degree.

These "learn-by-doing" courses are offered for year-round enrollment, and each consists of 13-15 written assignments and two proctored exams. Students may go from enrollment to completion in their own hometowns; the materials are sent by insured, return mail when the course applications are received. The exams may be proctored by an approved examiner in the enrollee's locale. Assignments are completed on self-paced schedules and mailed to the Independent and Correspondence Study Course at OSU for evaluation by Dr. Jones.

The courses are designed around a syllabus, the learner's guide to the course information. Those guides serve much the same purpose as a professor's classroom lecture and are designed to supplement the course textbook.

Of interest to career professionals may be the special reduced-tuition rate available to persons who need the information in the courses, *but do not want college credit.* They may submit the written assignments only and omit the proctored exams; upon successful completion of the course, students selecting that option will be awarded a Certificate of Completion appropriate for framing.

For more information on either of the courses, write Independent and Correspondence Study, 001 Classroom Building, OSU, Stillwater, OK, 74078 — or call (405) 624-6390. Be sure to specify the course for which information is wanted.

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11303	16	.64	.58	.48
11304	18	.73	.66	.55
11305	20	.99	.90	.75
11306	22	1.12	1.02	.85
11307	24	1.25	1.14	.95
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11204	18	.18	.17	.15
11205	20	.20	.18	.16
11206	22	.22	.20	.18
11207	24	.24	.22	.20
11208	28	.28	.26	.25
11209	40	.40	.37	.33

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13808	SOLV30-5	5	6.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
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13810	SOLV30-15	15	3.3A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
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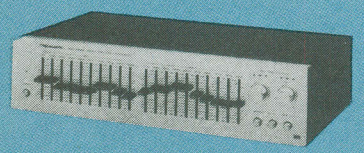

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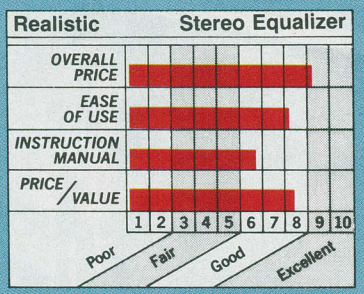

IN THE EARLY DAYS OF STEREO, FEW PEOPLE took time to worry about custom-tailoring the sound of their sound systems or enhancing recordings made with those systems. For most, it was simply a matter of installing a system and hoping for reasonable sound reproduction. Actually, there wasn't really any choice, because equipment for fine-tuning frequency response was not readily available. But times changed, tastes grew more sophisticated, stereo equipment improved, and people wanted better performance. Also, there was a growing awareness that everything in the listening area had an influence on the quality of the sound that could be obtained. Rugs, furniture, walls, ceiling height, and speaker placement all had their effects—often detrimental. To overcome those obstacles, something was needed.

What was needed was not a new device. Rather, it was one that had been around for years in the professional audio industry—the equalizer, a device for boosting or cutting frequency response at a number of points in the audio spectrum to obtain the best response under a given set of conditions. The equalizer was, and still is, one of the most important signal-

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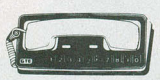

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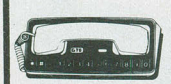

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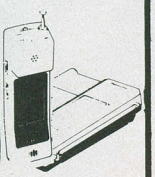

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CIRCLE 56 ON FREE INFORMATION CARD

processing devices used in the professional recording studio. At first, equalizers were expensive affairs, but quality equalizers for the home became available at modest prices, and they were then readily adopted by owners of stereo equipment.

One example of a high quality, low priced equalizer is the $159.95 Realistic ten-band *Wide Range Stereo Frequency Equalizer* (catalog number 31-2000) distributed by Radio Shack (One Tandy Center, Ft. Worth, TX 76102). It is gives you control over the frequency response of your stereo system in ten frequency bands per channel.

There are twenty frequency slide-controls (ten per channel) on the front panel. They are used to vary the frequency response at 31, 62, 125, 250, 500, 1000, 2000, 4000, 8000, and 16,000 Hz. You may wonder why you would need an equalizer when you already have bass and treble controls on your stereo amplifier. Well, those controls can have too much of an effect. Say, for example, that you move your speakers from a shelf to a stand on the floor. As a result, you may find that the bass response below 100 Hz drops. If you were to turn up the bass control on your amplifier, you would not only increase the response below 100 Hz, but you might increase the response up to several hundred Hz, resulting in an unwanted "muddy" sound. The equalizer can be adjusted to compensate only for the loss of the lower bass while leaving the response in the middle-bass range untouched.

The equalizer can be used not only to compensate for the acoustics of the listening area, but can also enhance and improve recordings you make. It can get rid of high-frequency distortion, while adding the bass needed in some instances. For example, you may have had the experience of making a cassette tape that sounded good on your home system, but that sounded awful when you listened to it on another one, such as a cassette player in an automobile. With an equalizer, you can compensate for the car's acoustics when you make the tape.

You can also compensate for the quality of the source material that you are recording—an old scratchy record for example. By decreasing the high-frequency response you can stop much of the hiss and scratches from showing up on the recording.

Setting up the unit

In a typical home system, an equalizer is placed in the tape loop of the amplifier. Then, the equalizer can be used to process the signal from the amplifier that will be recorded or listened to. That amplified signal can be from any source—a phono cartridge, a tuner, or even a tape deck. Let's see how that's done.

The various ways that the equalizer can be used depends upon the settings of the BYPASS, TAPE MON (tape monitor), and EQ REC (equalization record) buttons on the unit. For instance, depending on how you set the EQ REC button, you can use the device to equalize the signals fed to your amplifier while leaving the signal to your tape deck untouched, or you can equalize both the signals to be amplified and recorded.

Using the TAPE MON button, you can equalize program material that is being played back on your deck. If you press both the EQ REC and TAPE MON buttons, you will then be able to hear the equalized signals that are being recorded. Of course, if you have a three-head deck, you will be able to listen to the actual *recorded* equalized signals. In those ways you can compensate for problems with the source material (such as hiss and scratches on old records) as you make the recording.

When the BYPASS button is pressed in, it (as you might expect) disconnects the equalizer from the system. You cannot equalize any signals in that mode, but the TAPE MON switch will still function and allow you to listen to your tape deck.

Other controls

Overall, the 4½ by 16½ by 10¼-inch unit is cleanly designed and will blend in well with any component stereo system. The front panel includes (aside from the

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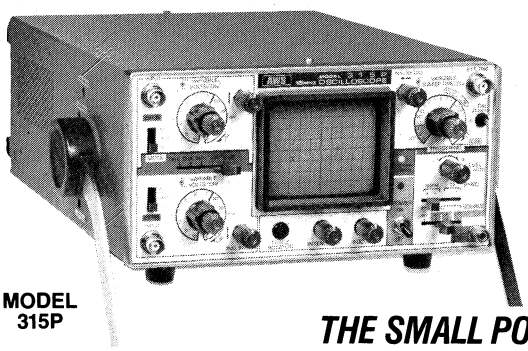

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SPECIFICATIONS

Vertical System CH. A and CH. B*- Deflection Factor,** 2mv/div - 10v/div, 12 steps • **Frequency Response,** DC - 15 MHz (−3 dB) • **Risetime,** 24 ns • **Maximum Input Voltage,** 300 V (DC + AC peak) • **Input Impedance,** 1MΩ ±5%, 20pF ±3pF • **Display Modes,** CH-A, CH-B, DUAL, ADD, CHOP • ***Internal Horizontal System (Sweep Operation) • **Deflection Factor,** 0.5μs/div. - 0.5s/div (±5%), 19 steps • **Magnification,** 5x all ranges • ***Trigger System*** - **Sources,** INT, CH-A, CH-B, EXT • **Modes,** AUTO, NORMAL • **Sensitivity,** INT: 1 Div or more, EXT: 1V p-p • **Coupling,** DC, TV SYNC.

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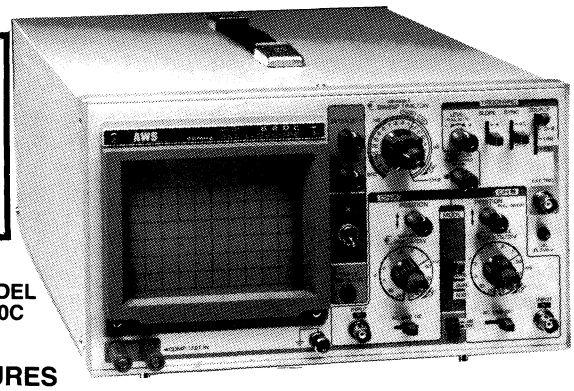

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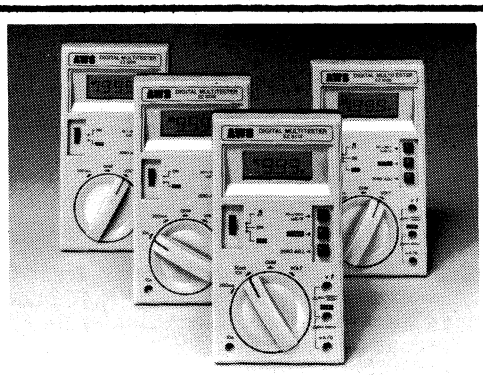

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twenty boost/cut controls and BYPASS,EQ REC, and TAPE MON buttons) a power switch and an LED power-on indicator, two ZERO-GAIN controls and their LED indicators.

The ZERO-GAIN controls are used because after equalization, the output signal levels may be higher or lower than the original input to the equalizer. The ZERO-GAIN controls must be used to restore the level of the original signals. The two large knobs are located on the front right of the panel and above each knob are three LED's. Those LED's serve as indicators for the correct levels—whether the level is too high, too low, or "zero." Using those indicators ensures that the amplifier and/or speakers will not be driven into distortion.

Now that we know what is on the brushed-aluminum front panel, let's take a look at what's contained on the flat-black rear panel. That panel houses the unit's input and output connectors. An unswitched, AC convenience outlet is also included.

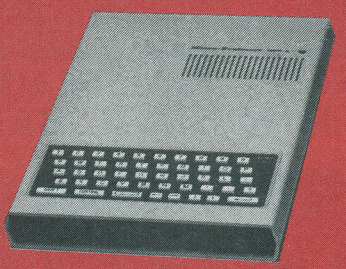
The intermodulation distortion of the equalizer is specified as 0.02 percent at 0.775 volts, while harmonic distortion is the same from 20 to 20,000 Hz. Hum and noise are 80 dB down at 0.775 volts, while the dynamic range permits signal levels up to 10 volts rms. Bench testing confirmed that those figures were accurate to within 5 percent.

Overall, the Realistic *Wide Range Frequency Equalizer* was easy to use, but required a great deal of experimentation to get the most out of it. The instruction manual gives a few pointers to help make understanding the control settings easier. It includes a chart showing the approximate frequency ranges for some musical instruments and for male and female voices. Granted, each audio enthusiast's tastes are different, as is each listening area, but the owner's manual had few actual user-hints about initial settings. However, the manual was very strong on theory of operation, perhaps under the assumption that it would aid the beginning user. The setup pictorials were clear and straightforward.

Once the familiarization process was over, the equalizer became a welcome addition to my audio system. Sound reproduction from records and tapes became much more realistic and lifelike, with basses enhanced and the top ranges sharper and clearer. The same was true of recordings I made.

In conclusion, the Realistic *Wide Range Frequency Equalizer* is a good buy. Its performance is good and it will make a welcome addition to anyone's system. Although the novice user may be a bit confused by some shortcomings of the documentation, that confusion should be short-lived and easily overcome with a bit of experimentation. **R-E**

Micro-Professor II Microcomputer



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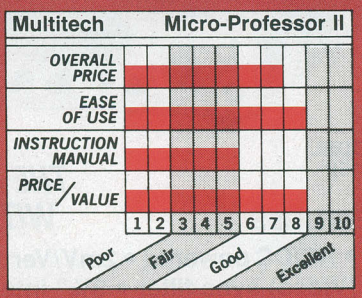

AS HAS BEEN APPARENT TO ANYONE watching microcomputers over the last year or so, they are getting smaller. Not that micros were ever *that* large, but they have now come down from tabletop size to pocket size. And, in the category just

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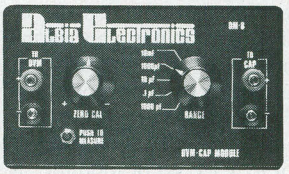

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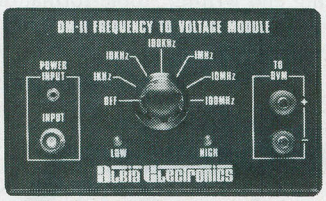

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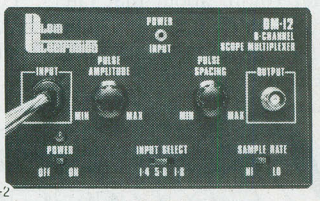

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over "pocket size" there are several entries—most prominent among them being the Timex/Sinclair *1000*. In that same size category is another computer that we recently had the pleasure of examining, the *Micro-Professor II* from Multitech Electronics, Inc. (195 W. El Camino Real, Sunnyvale, CA 94086).

The *Micro-Professor II* is slightly larger than the Timex/Sinclair computer, measuring about 7 × 10 × 1-inches. Inside that small package, though, lives a very powerful system. You see, Multitech's *Micro-Professor II* thinks it's an Apple.

It would be hard to call the computer an "Apple look-alike" because of its small size, but, if you disregard that, you might very well think, on the basis of performance, that that's what you had in your hands.

Physical characteristics

There's an awful lot packed into the *Micro-Professor II's* 70-cubic-inch beige plastic case. In addition to a full 64K of RAM, 56K of which is available to the user (the rest is reserved for display memory and for system use), the computer also boasts 16K of ROM. Three-quarters of that, or 12K, is dedicated to a BASIC interpreter (more about that later). The microprocessor used is a 6502. That is, of course, the same type found in the Apple computers.

The keyboard is, as you might expect in a device this size, smaller than standard, but the fact that it has button-type keys, rather than a membrane keyboard like the Timex/Sinclair, makes it fairly easy to use. Most of the keys are in the familiar locations and it's possible to touch-type to a certain extent, although word processing is pretty much out of the question. (Multitech indicates that a full-size keyboard is available as an option for $39.00.)

Also included in the case is a small speaker—the *Micro-Professor II* has sound-generating capabilities—a slot for ROM cartridges containing a variety of software, two connectors for peripherals, and, on the rear, four jacks.

Two of the jacks are for connections to a cassette recorder, and the two remaining ones are for video output. *Color* video. One jack provides composite video for direct connection to a monitor, while the other makes available an RF signal on TV Channel 13. While we are used to modulators that output on Channel 2 or 3, the Channel 13 choice is not a bad one—it is high enough in frequency so that much of the RF inteference generated by the computer (and *all* computers generate RF to some extent) is attenuated, and viewing the computer's display on a TV receiver is essentially interference-free. A screwdriver-adjustable fine-tuning capacitor can be reached from the bottom of the case, although we found no reason to have to use it.

In addition to being able to reproduce sounds through its built-in speaker, the computer modulates its RF signal with audio, so that you can listen through the speaker of the TV set being used as a display unit.

The *Micro-Professor II* uses a switching-type power supply in a separate case that also contains the ON/OFF switch. The supply runs a bit warm to the touch, but seems reliable and gave no problems during the time we used the computer.

The computer comes with a cable to connect it to a TV set or monitor, as well as with a game-type antenna switch. All you have to add are the cables for the cassette recorder.

The computer offers several tape modes. Not only will it read and record tapes in its own format, but it can also read and write tapes in Apple format. From what we've seen, both modes work well. It may take a little adjustment to find the correct playback volume-level, but that setting is not overly critical (especially when compared to other computers of this type). There should shortly be available a 5¼-inch floppy-disk drive capable of reading and writing Apple-format disks. A printer and add-ons like joysticks and a speech synthesizer are also on the way.

continued on page 39

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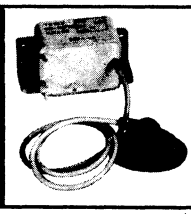

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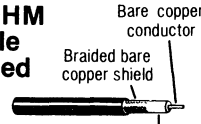

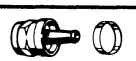
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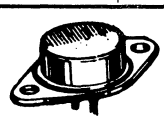
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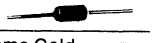

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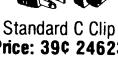

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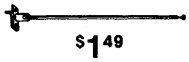

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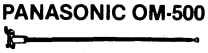

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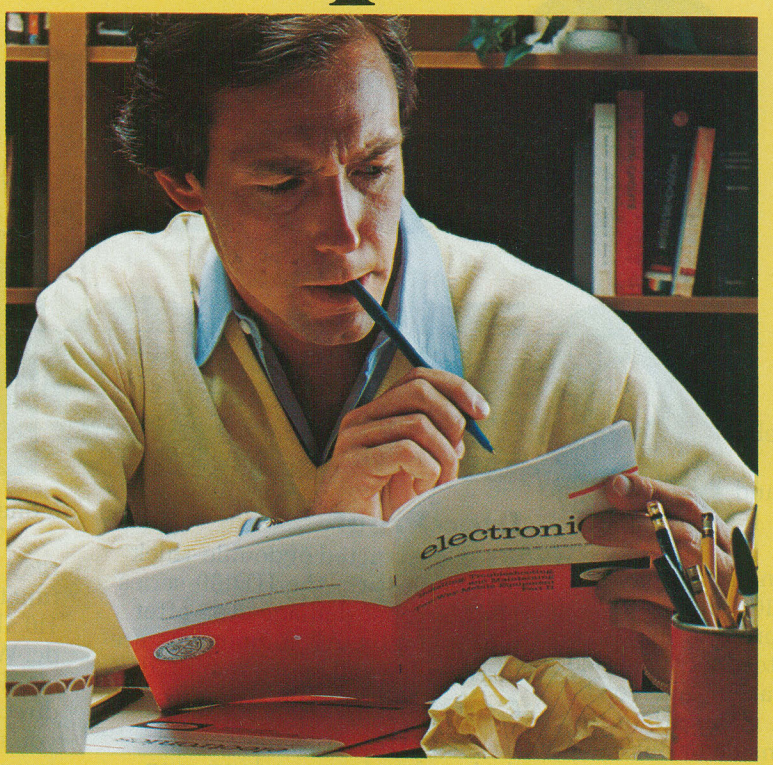

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The Gillaspie is not a toy or kit you have to assemble. It is a complete *system* which includes the same 6-foot "dish" antenna which was the sensation of the recent Satellite TV Trade Show in Atlanta. Of some 150 antennas demonstrated, from 8-foot to 20-foot diameter, Gillaspie's was the *only* 6-foot. Sophisticated t.v. engineers approached this easily installed antenna, suitable for nearly any home, in utter disbelief, but their skepticism vanished when they viewed the studio-monitor quality pictures it delivered when coupled to the Gillaspie 7600A receiver that is the heart of your Gillaspie Satellite TV Earth Station.

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7600A	6 Foot Antenna
• Receiver frequency range: 3700 to 4200 MHz • Full frequency tunable audio for all subcarriers: 5 to 8 MHz • Simplified channel tuning • Built-in video modulator • Improved video performance circuitry • Automatic frequency control • Signal strength carrier level meter • Attractive all wood cabinet • Definitive Gillaspie quality control	• High gain • Direct broadcast application • Ease of installation • Complete orbital coverage • Precision spun aluminum reflector • Hot dipped galvanized steel mount • Hot dipped galvanized or stainless steel hardware

Perhaps Only a Receiver as Good as the Gillaspie can deliver good video from a 6-foot antenna, but deliver it does, and we guarantee it with our money-back-if-not-satisfied warranty*. The Gillaspie 7600A receiver has been proven the standard of the industry with over 8,000 units in use by t.v. stations, cable systems, industrial users, and individuals throughout the world.

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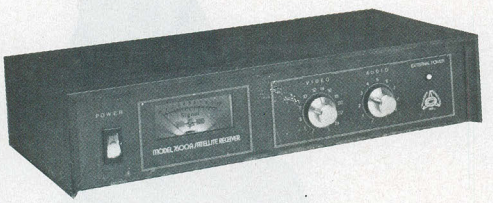

On the 7600A All Channel Selections are controlled from the comfort of your easy-chair by the convenient optional remote control unit. Ask your dealer about handy satellite program guides, published weekly and monthly. Provisions have been made for sharing of an antenna among neighbors for even further savings!

Sounds Too Good to Be True: Is It Legal? Perfectly, as long as you don't charge admission and open a theatre in your home. The Federal Communications Commission has specifically de-regulated satellite t.v. reception by private individuals for personal enjoyment.

The Gillaspie Model 5800 Portable is a completely self contained high performance satellite receiver, t.v. set, signal meter, signal scanner, with rechargeable battery pack and charger all in one small portable unit! It is light weight, fits under an airplane seat and is perfect for site surveys, R.V.'s, antenna alignment and system trouble shooting.

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Note: Satellite TV reception may vary in certain locales. Check with your nearest Gillaspie dealer.

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EQUIPMENT REPORTS

continued from page 32

Software

The monitor and BASIC contained in the computer's ROM are remarkably similar to those used by the *Apple II*. Any Apple user will have little difficulty in programming the *Micro-Professor II*. All the little niceties are there—things like the LOMEM and HIMEM commands (that let you set memory boundries). There are also high- and low-resolution graphics modes. Resolution in the low-resolution mode is 40 × 48 pixels with six colors available; in the high-resolution mode it's 280 × 192 pixels, again with six colors available.

Enhanced BASIC commands allow lines and arcs to be plotted easily. Provision is made for the user to define his own shape tables for special graphics characters, in addition to those special symbols already programmed into the computer's character generator.

As mentioned earlier, the computer has sound-generation capabilities, but we were unable to test them (except by hearing them when running demo programs) because no instructions for programming for sound were given in the documentation that came with it.

Since we've already mentioned many of the similarities between the *Micro-Professor II* and Apple's computers, we should now mention that the unit has several nice features that the Apple computers haven't. One is an on-screen indication of the length of the program being loaded from tape, as well as a "progress report" as the program is loaded from tape into the computer's memory. Another is the ability to use one-key BASIC commands. That feature is made convenient by a template that slips over the keyboard to indicate which key performs which function.

Besides coming with a game program (Space-Invaders type), the computer also comes with a diagnostics program on tape called *Micro-Nurse* that quickly checks out (among other things) RAM, ROM, the video and sound generation sections, the built-in math functions, the keyboard, and the cassette interface.

According to the information supplied by Multitech, a wide variety of software—both cassette and cartridge-based—is available or on the way. There are games, of course, but there are also programs for such areas as business management, statistics, and education. Programming languages like Pascal, Forth, an assembler, Pilot and *Chinese* BASIC are also either promised for the future, or are already available.

The Chinese BASIC is interesting, even though we haven't seen it. The *Micro-Professor II* is manufactured in Taiwan, and can be ordered in a Chinese-language version at extra cost. Its graphics capabilities make it ideal for displaying the oriental character-set. Much of the language software that is being offered seems to be intended for the Chinese-speaking student wishing to learn English.

The computer comes with several short instruction manuals (one on setup, and one on using the *Micro-Nurse* program) and a book entitled *MPF-II Programming Manual*. That book is a combination course in BASIC and in using the computer. While it is fairly extensive, it unfortunately contains a number of errors (mostly typographical) which may confuse or frustrate the beginner. One of the most glaring is the inclusion of two different commands for reading a tape. Fortunately, one of them works. Also absent is a section on making use of the computer's sound-generation feature. Perhaps later editions of the book will be better, but it would be a good idea for the first-time user wishing to make the most of his computer to have on hand alternate reference works on BASIC—some of the books that have been written specifically for the Apple computers would probably be ideal.

Overall, Multitech has not done a bad job in packing so much into such a small package. For the $399.00 list price you could do a lot worse. **R-E**

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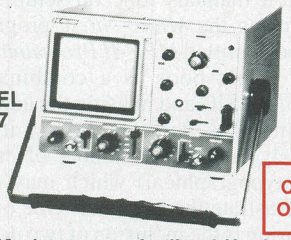

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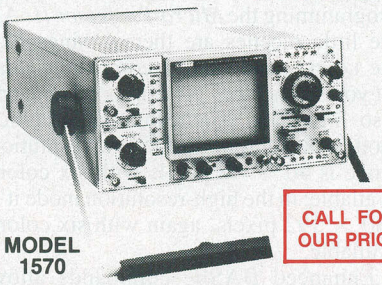

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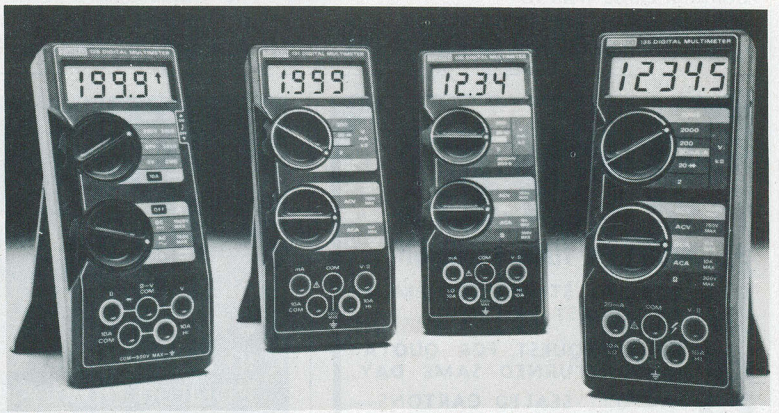

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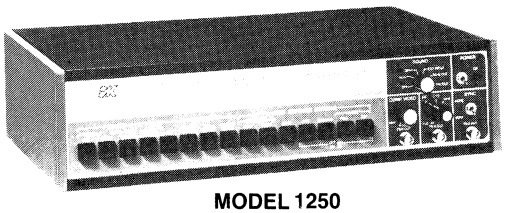

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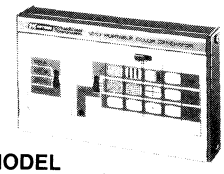

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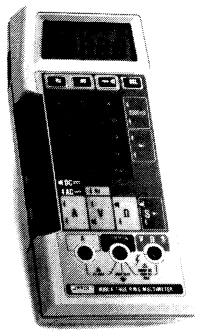

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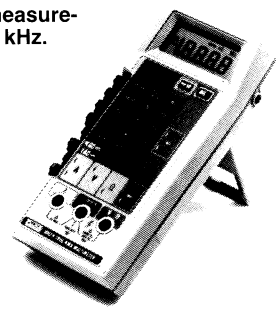

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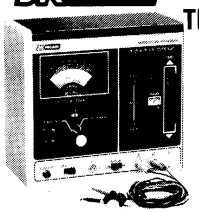

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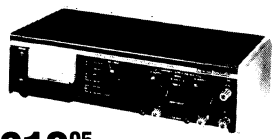

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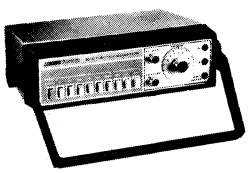

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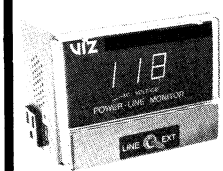

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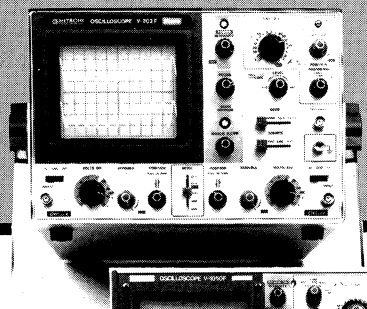

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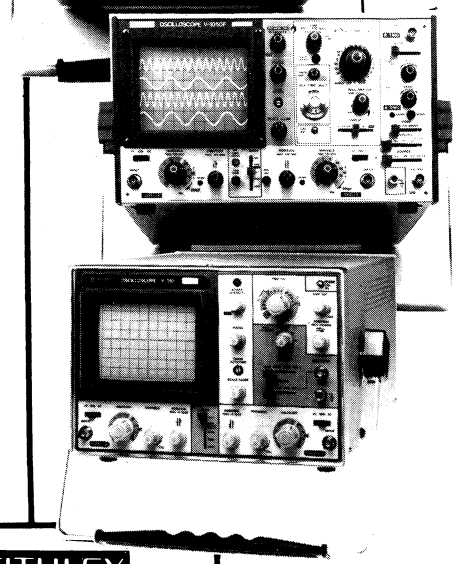

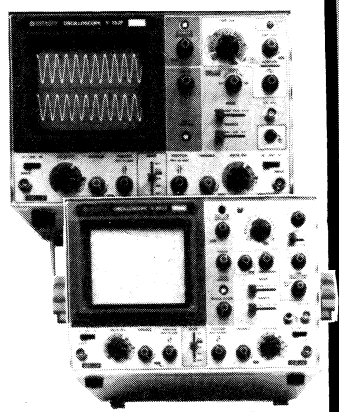

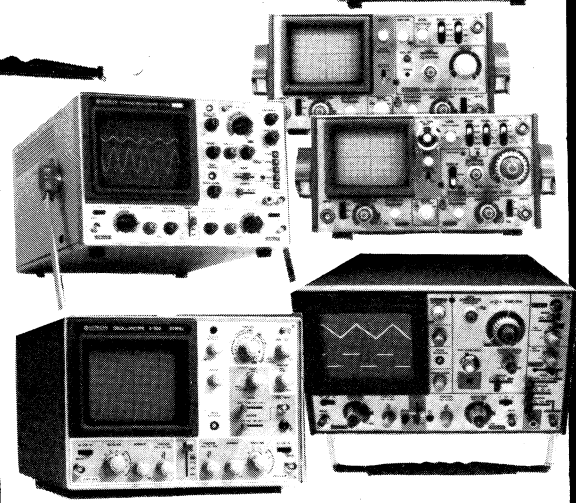

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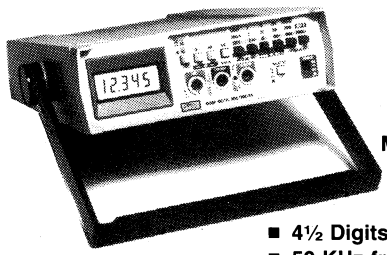

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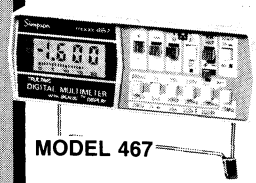

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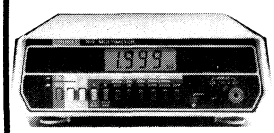

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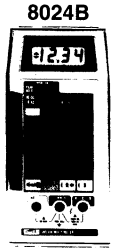

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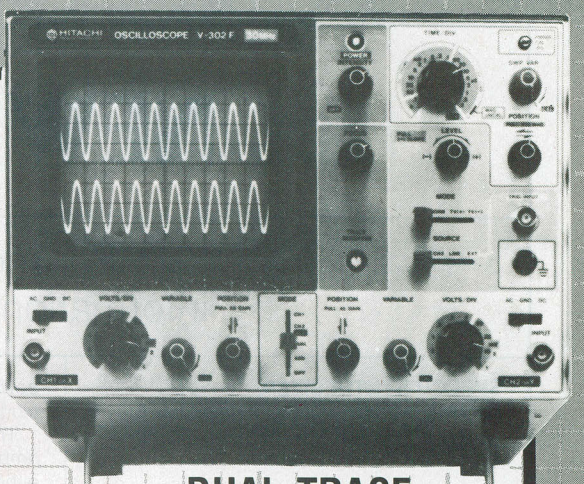

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Max. Input Voltage	600Vp-p or 300V (DC + AC peak, at 1kHz)
Input Coupling	AC, GND, DC
Input Impedance	Direct 1M ohm, approx. 30pF
Operating Modes	CH1, CH2, DUAL, ADD, DIFF
X-Y Operation	CH1: X axis, CH2: Y axis
Sensitivity	5mV/div to 5V/div (when using x5 amplifier: 1mV/div)
• Horizontal Deflection	
Trigger Modes	AUTO, NORM, TV (+), TV (–)
Trigger Source	CH1, CH2, LINE, EXT
Trigger Coupling	AC
TV Sync	TV sync-separation circuit
Internal	1 div or more (V sync-signal)
External	1Vp-p or more (V sync-signal)
Trigger Sensitivity	Frequency / Internal / External 20Hz to 5MHz / 0.5div / 200mV 5 to 30MHz / 1.5div / 800mV
AUTO Low Bandwidth	30Hz
Trigger Slope	+
External Trigger Input	Input impedance: approx. 1M ohm, 30pF or less Max. input voltage: 100V (DC + AC peak at 1kHz)
Sweep Time	0.2μs/div to 0.2s/div, ±5% 19 calibrated steps Uncalibrated continuous control between steps 1: < 2.5 (provided with click-positioning function)
Sweep Time Magnifier	10 times (±7%)
Max. Sweep Time	100ns/div (20ns/div and 50ns/div. not calibrated)
• Power Requirements	100/120/220/240V ±10% 50 to 60Hz. approx. 40W
• Dimensions	Approx. 275(W) x 190(H) x 400(D) mm
• Weight	Approx. 8.5kg

FEATURES

- 1 mV/div high sensitivity design. Effective for measurement of weak signals.
- Employs TV sync separator circuitry with one touch synchronization of both TV horizontal and vertical signals.
- Built-in signal delay line enables front observation of fast rising waves.
- X-Y operation convenient for measurement of phase difference between two signals.
- Delayed sweep function with one touch control 10X magnification.
- Trace rotation system for easily adjusting trace inclination caused by terrestrial magnetism.
- Fine adjusting click positioning function enhances measuring efficiency.
- Signal output: CH1 output terminal to Frequency Counter, etc.
- Z axis input provided – possible to use as CRT display.
- One touch shifting of waveform slopes for easy observation of rise and fall of waves.

Price does not include probes.
Probes $50. a pair when purchased with scope. $10. shipping within continental U.S.

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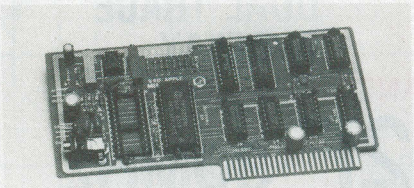
SPEECH SYNTHESIZER, the *SSB-APPLE,* is a plug-in board that gives *Apple II* users an easy and economical way to add speech capabilities to their systems.



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The board can be used for language instruction, speech therapy, video games, experiments in speech synthesis, and many other applications. Its 1200-word vacabulary is the largest one presently available for the *Apple II.*

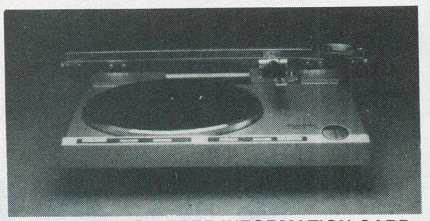
The 2.75 × 6-inch board is based on Texas Instruments' model *TMS52220* high-performance speech-synthesis device; it plugs into any spare slot of the *Apple II.*

The *SSB-APPLE* has an on-board audio amplifier, which provides 325 mW to drive either the built-in *Apple II* speaker or any external 8-ohm speaker. A socket is also available to expand the unit's voice-synthesis memory by adding a TI TMS6100 chip. Included with the board are a 5¼-inch floppy diskette containing the 1200-word dictionary (in digitized form), a complete instruction manual, and a stand-alone high-quality speaker.

The *SSB-APPLE* is priced at $195.00.—**Multitech Electronics, Inc.,** 195 W. El Camino Real, Sunnyvale, CA 94086.

TURNTABLE, model *8000A,* has an advanced linear motor which contributes to its high signal-to-noise ratio, elimination of tracking error, low wow and flutter, and neutral skating force.

The model *8000A* also features a polymer graphite tangential-tracking tone arm with a direct-induction linear motor for improved tracking ability. An opto-electronic detector cell senses tracking error and corrects the tone-arm position. The stable hanging rotor eliminates "platter wobble" and the quartz-PLL (*P*hase-*L*ocked-*L*oop) system, combined with frequency-generator reference, helps maintain accurate motor speed. A double isolation suspension system minimizes acoustic feedback and susceptibility to vibration. The tone arm can be operated by push-



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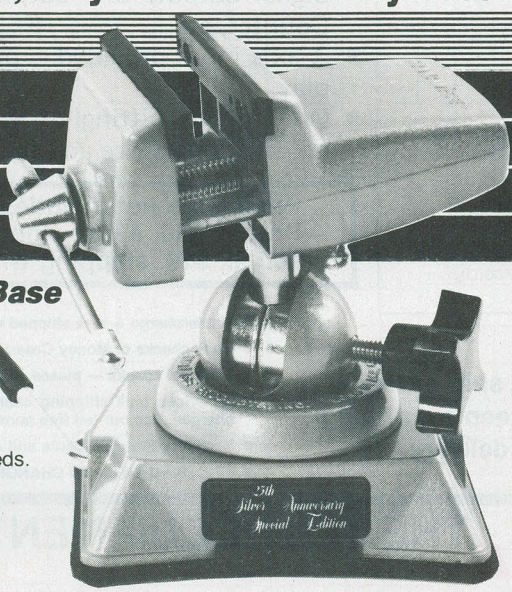

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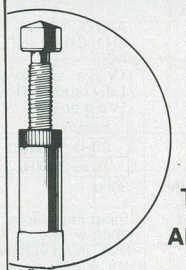

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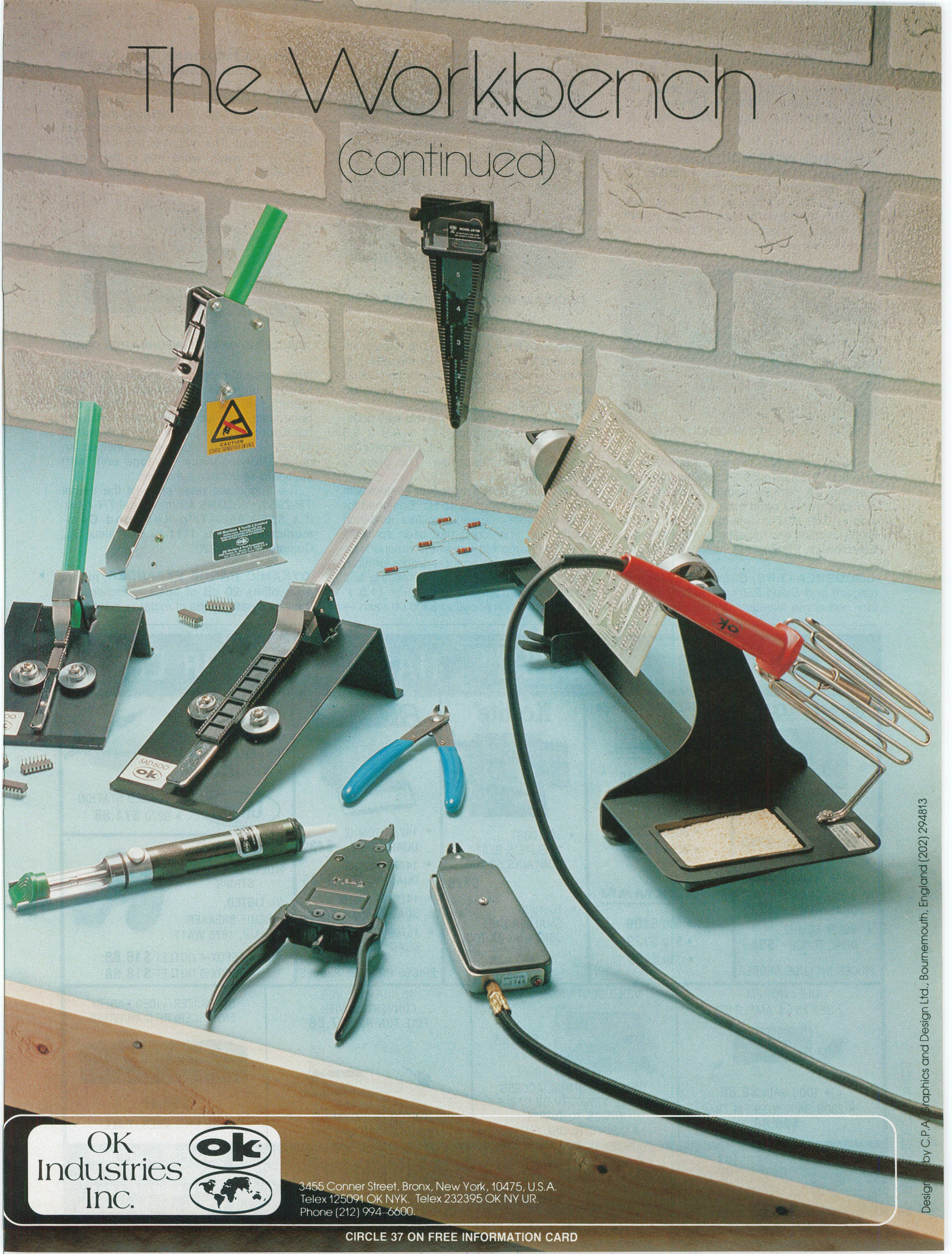
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button control even when the dust cover is closed.

The model *8000A* has a suggested retail price of $650.00.—**Phase Linear,** 4136 North United Parkway, Schiller Park, IL 60176.

EXPANSION INTERFACE, model *T1000,* is a 32K-plus-I/O unit that adds 4 parallel I/O ports and 32K of memory to the Timex/Sinclair *1000* or the Sinclair *ZX-81* computer. The unit plugs into the back of the computer and makes it possible for you to interface it with the real world.

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The model *T1000* expansion interface is priced at $155.00 plus $4.95 shipping and handling. (A partially populated board that provides the I/O ports and room for expansion to 32K later is available for $50 plus $4.95 shipping and handling.)—**Wisconsinc Electronics,** PO Box 332, Milton, WI 53563.

LOUDSPEAKERS, *Ditton 110 Mark II* (shown) and *Ditton 250* both feature the 1-inch soft dome tweeter that was developed

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and used in the first generation of laser-developed *Ditton* speakers. The tweeter offers wide dispersion and has the ability to reproduce musical peaks cleanly and accurately. Both systems also offer accurate stereo imaging.

The *Ditton 110 Mark II* is a two-way bookshelf speaker measuring 17.7 × 9.9 × 8.3 inches, and contains an 8-inch woofer for improved bass response. The price is $200.00 each.

The *Ditton 250* is a three-way system with bass response range to 45 Hz. Designed for 10-80 watt (per channel) amplifers, its 8-inch woofer with fiber cone has been specially treated to damp out unwanted resonances. Its PVC roll surround ensures proper termination of vibrations, eliminating standing and traveling waves. It measures 22.5 × 11.5 × 9.4 inches, and is priced at $300.00 each.—**Celestion Industries, Inc.,** Kuniholm Drive—Box 521, Holliston, MA 01745.

MOBILE TRANSCEIVERS, model *TR-7950* (shown) and model *TR-7930* are 2-meter mobile transceivers identical in features except for RF output. The output of the model *TR-7950* is 45 watts, while that of the model *TR-7930* is 25 watts. Both models offer a

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large, easy-to-read LCD display, 21 multi-function memories, automatic offset, programmable priority channel, memory and band scan, long-life lithium-battery memory backup (estimated 5-year life), and built-in 16-key autopatch. Accessories include an optional 3-frequency sub-tone unit, with keyboard-selectable subtones.

The suggested retail price of the model *TR-7950* is $300.95; for the model *TR-7930,* it's $359.95.—**Trio-Kenwood Communications, Inc.,** 1111 West Walnut St., Compton, CA 90220.

DYNAMIC RANGE EXPANDER, model *4BX,* offers 20 dB of noise reduction and three separate bands of expansion for high,

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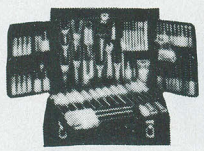

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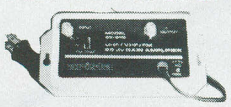

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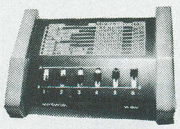

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Input: BNC	
Impedance:	1M Ω @ 25pF in all modes
Sensitivity:	30 mVRMS — 1 kHz to 30 MHz 50 mVRMS — DC to 50 MHz
Modes:	
Frequency:	.1 Hz to 50 MHz (gate times 0.01, 0.1, 1.0, 10 s)
Period:	50 ns to 10 s (1, 10, 100, 1000 cycle averages)
Pulse Width:	25 ns to 10 s (1, 10, 100, 1000 cycle averages)
Full Signal Conditioning:	
Coupling:	AC or DC switch selectable
Attenuation:	x1, x10, x100 switch selectable
Polarity:	+/− edge Freq. & Period; >/< trigger level, Pulse Width
Trigger Level:	variable 0 ± 500 mV x attenuator setting
Time Base:	10 MHz crystal oscillator (± 4 ppm,0-40°C.)
Controls:	Power/Test/On, Mode, Gate Time/Cycles Averaged, Display-Norm/Hold, Trigger Level, Polarity, Coupling, Attenuation
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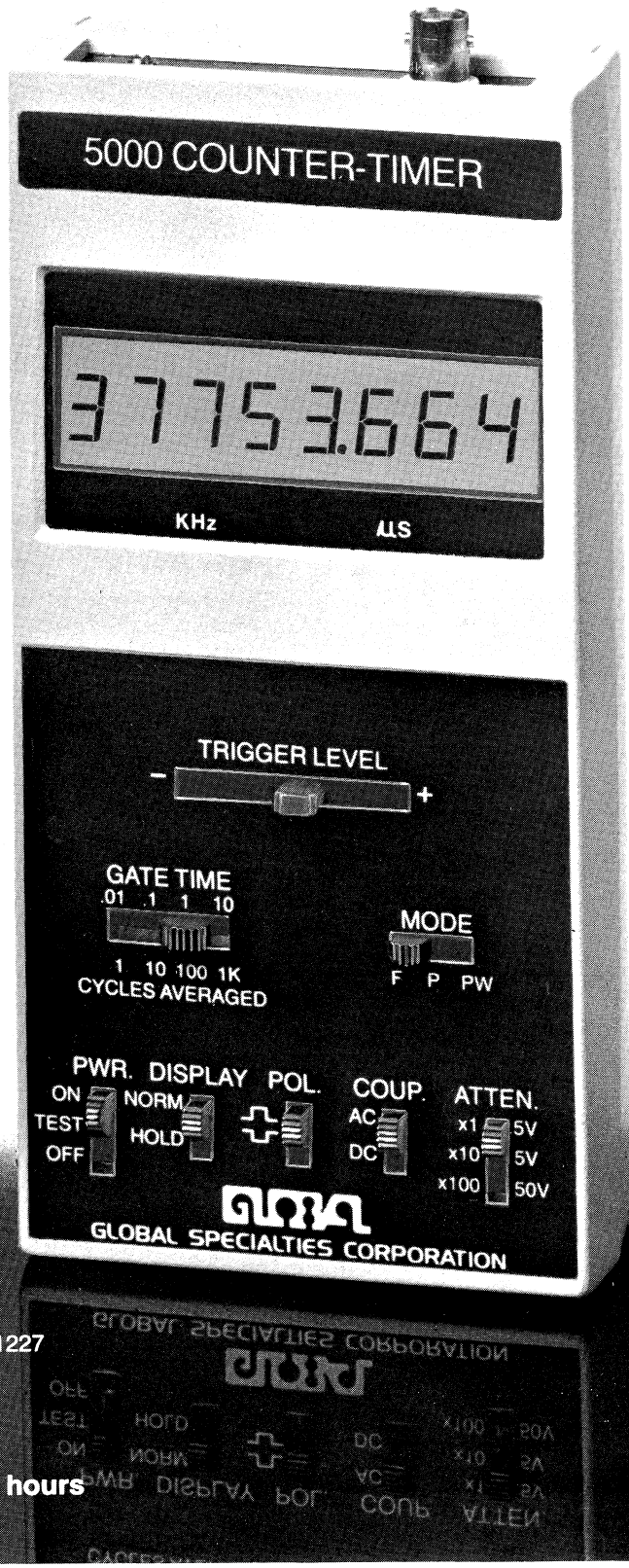

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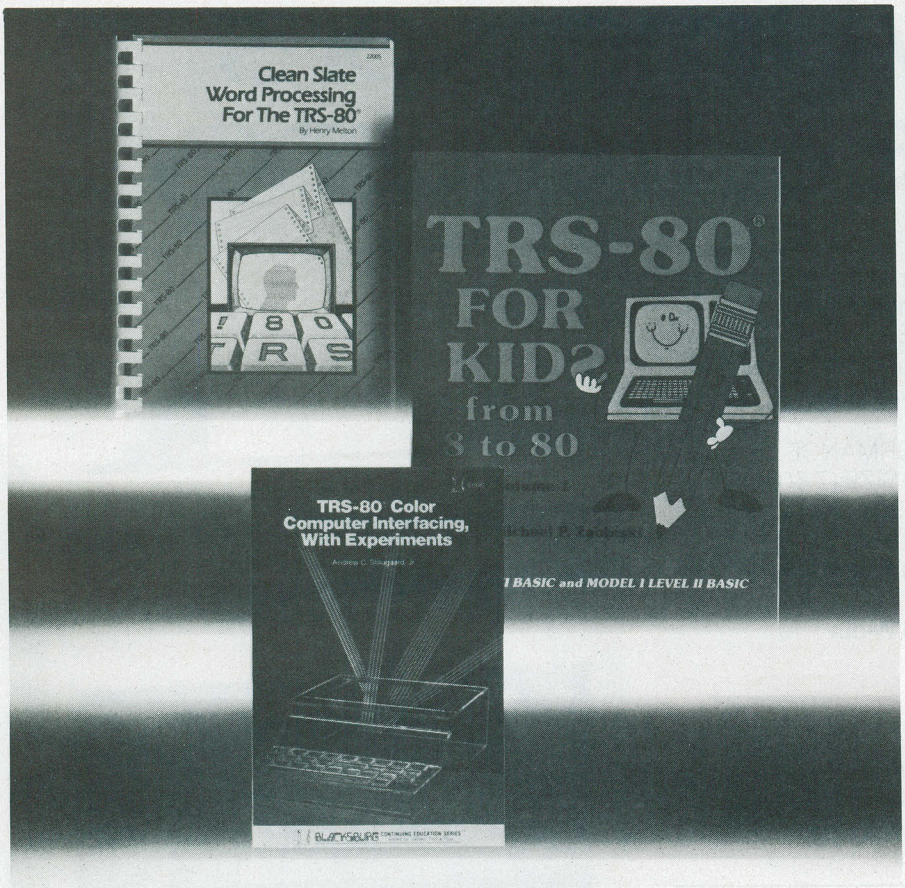

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mid, and low frequencies. A fourth band recaptures the stored, previously unreachable audio signals, the omission of which has been responsible for the lack of presence or dullness common to much recorded music. It

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restores the transients that are clipped during the recording or broadcasting processes.

A hand-held, digital, wireless remote "Logicontrol", which is supplied with the model *4BX*, allows the user to set volume and degrees of expansion, transition, and impact-restoration levels precisely from the listening position. The actual tracking of the music signal is displayed on four horizontal rows of program-dependent yellow and red LED's, which show the amount of expansion.

The model *4BX* is 3½ × 17 15/16 × 12¼ inches, and comes with 19-inch standard rack-mount hardware for its faceplate. An optional wood side-kit will be available. The model *4BX* is priced at under $1000.00.—**dbx, Inc.,** 71 Chapel Street, Newton, MA 02195.

DMM, model *3500,* is a hand-held, 3½-digit, 22-range digital multimeter that uses CMOS LSI circuitry to provide autoranging, autopolarity, overrange, and low-battery indication in a compact tester that the user will find easy to operate.

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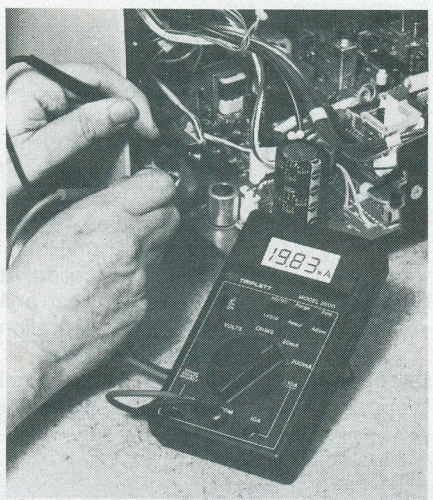

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Ranges are: DC volts: 0-1000 volts DC in five ranges; AC volts: 0-600 volts AC in four ranges; low-power ohms: 0-2 megohms in four ranges; high-power ohms: 0-2 megohms in five ranges; AC and DC current: 0-10 amps in three ranges. Frequency response is 40-500 Hz on all ranges. Basic DC accuracy is 0.25%.

The model *3500* is priced at $140.00.—**Triplett Corporation,** One Triplett Drive, Bluffton, OH 45817. **R-E**

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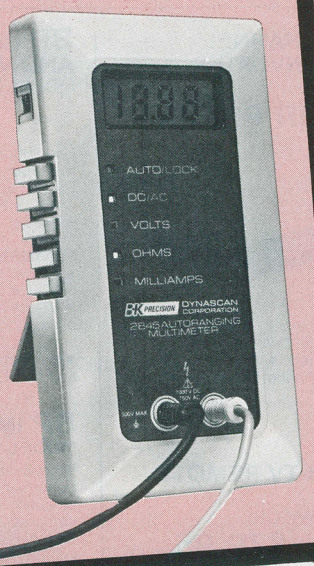

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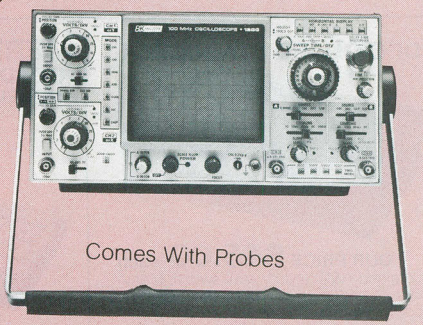

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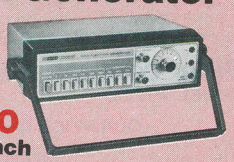

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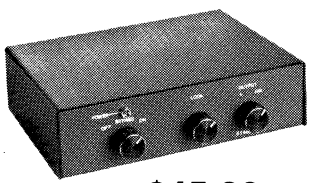
RF Converter Allows your TV set to receive video and audio signals from your image enhancer, guard stabilizer, video camera, computer, VCR, etc. The direct video signal from any video component can be fed into the V-1880 and converted to a usable RF signal that can go to your TV antenna terminals.
Video Fader Used to produce professional fade ins and fade outs.

BP VIDEO GUARD STABILIZER

MODEL V-1875



OUR PRICE $45.00 each

Has self contained A&B and bypass switch. Many movies, concerts and special programs for sale or rental are copy guarded. This removes copy guard and allows you to make copies. Many TV sets will not play prerecorded tapes because copy guard causes picture to roll and jitter, turn to snow or disappear. Video Guard Stabilizer removes copy guard from signal.

BP VIDEO GUARD STABILIZER/ RF CONVERTER

MODEL V-1877

OUR PRICE $69.95 each

Same as above but with a built-in RF Converter that gives the model V-1877 an RF output which can be fed directly to the antenna terminals of a TV set. This enables you to remove the copy guard from a pre-recorded tape and view it on a TV using only a VCR.
Use as an RF Converter only. Used in conjunction with your TV, you can feed direct audio and video signals from any video device such as video camera, computer, portable VCR, etc.

BP VIDEO COMMAND CENTER

MODEL V-4803

OUR PRICE $59.95 each

A switcher that can accept 6 inputs and direct them to 3 outputs. Utilizes switch similar to one used on home VCR's. You avoid signal loss incurred by using splitters.

JERROLD 60 CHANNEL CORDLESS TV CONVERTER

MODEL DRX-3-105

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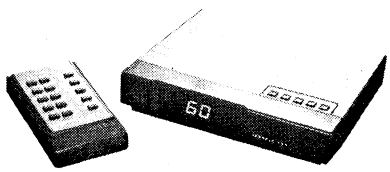


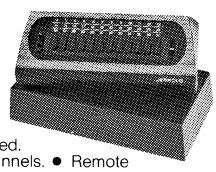
• Receive up to 60 TV channels • Remote TV Control • Attach to any age or model TV in minutes. • No tools required. • On/Off button. • Channel selection. • Channel Stepping. • Fine Tuning.

JERROLD JRX TV REMOTE CONVERTER

MODEL JRX-3C105 (SWITCH)

OUR PRICE $79.95 each

Consists of two units - a receiver and transmitter. 20 ft. connecting cord is detachable at one end to help you position the unit. May be attached to any age or model TV in minutes. No tools required.



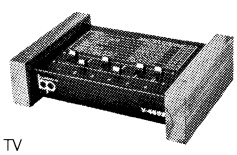
• Receive up to 36 channels. • Remote TV control.

BP VIDEO CONTROL CENTER

MODEL V-4802

OUR PRICE $19.95 each

Provides remote control access of all Video, TV or Cable inputs to TV or Big Screen TV from one location by flipping switch.



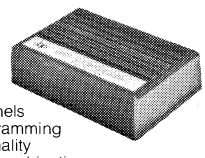
• One output, your TV set or Big Screen TV • Four inputs • Completely passive, i.e. no AC power required to operate • Auxiliary input and output provides added flexibility.

BP UHF CONVERTER FOR TV AND VTR

MODEL V-5736

OUR PRICE $24.95 each
5 FOR $100.00

Use your VCR to its maximum capability. Record VHF, UHF, Cable or Pay TV while watching any other mode.



FEATURES • 36 channels • Allows complete programming of VTR • Super color quality • Watch or record any combination of selectable channels. • Receives midband, superband/Pay and all VHF channels on UHF. • For Beta/VHS type recorders or TV set • Record and use TV's remote control.

BP IMAGE ENHANCER

MODEL V-1860

Dramatically improves performance of video cameras and VCR's, (off-the-air or second generation recordings), by compensating for deterioration of detail and sharpness. Includes video distribution amplifier with two video outputs, allowing you to make two copies at once without loss in signal level.

OUR PRICE $59.95 each

BP RF CONVERTER/MODULATOR

MODEL V-1885

OUR PRICE $39.95 each

Allows your TV to receive video and audio signals from image enhancer, guard stabilizer, video camera, computer, VCR, etc.

The outputs of many video components cannot be directly hooked up to the VHF antenna terminals on your TV set. This problem is solved by using the Model V-1885 RF Converter. Converts video signal from any video component to adjustable RF signal at antenna terminals. Allows your VCR output to feed two TV sets at the same time, with virtually no signal loss.

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BUILD THIS

AUDIO FREQUENCY RESPONSE METER

RAY FISH

Instruments for measuring frequency response have traditionally been complex and expensive. Here's an easy-to-use one that you can build for less than $25.

IT'S FREQUENTLY USEFUL—OR necessary—to know the frequency-response characteristics of audio equipment. This device will allow you to make accurate measurements of your amplifiers, tape recorders, and other audio and test equipment.

The instrument is most useful for "peaking up" tape recorders for optimum performance. It will permit you to measure the frequency response obtained with various brands of tape on your recorder and that, in turn, will make it possible for you to set the bias and equilization controls more accurately. If your tape heads become dirty or worn, the frequency-response meter will advise you of the fact long before you start noticing that your recordings do not sound right.

How it works

A block diagram of the device is shown in Fig. 1. The oscillator produces a constant-amplitude sinewave signal that's fed through a buffer/amplifier to the device being tested—a tape recorder, for example. The output signal from the device under test is fed back to the test unit, through another buffer/amplifier, and then to a meter calibrated in decibels (dB).

An 8038 voltage-controlled-oscillator IC generates the sinewave, which has about 1% distortion. That means that harmonics will be about 40-dB down, which is quite acceptable for our purposes.

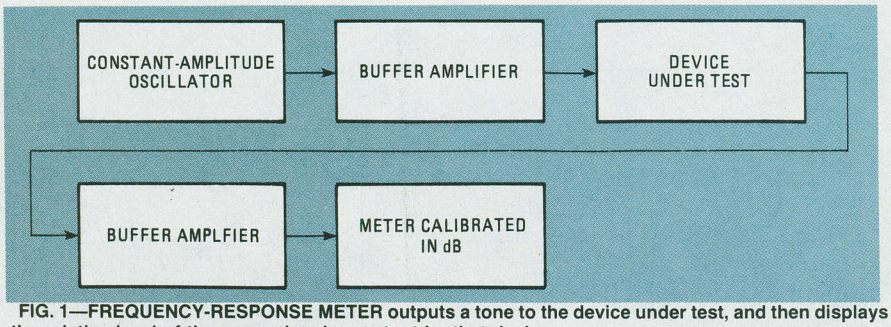


FIG. 1—FREQUENCY-RESPONSE METER outputs a tone to the device under test, and then displays the relative level of the same signal as output by that device.

Circuit description

Figure 2 is a schematic of the frequency-response meter. Resistor R2 is a potentiometer that functions as the (fine) frequency control. It varies the frequency over a decade (a factor of 10). Proper selection of R1 and R3 would allow R2 to give a three-decade change in frequency. That, however, would cause the dial markings to be so close together that it would be impossible to read the frequency with reasonable accuracy. Therefore, the frequency decades are selected by S1, which switches either capacitor C1, C2, or C3 into the circuit. Those capacitors should have a 2% tolerance, or should be trimmed as described in the "Adjustments" section.

Resistors R5 and R7 are used to adjust the waveform symmetry and to set the frequency of the oscillator, and resistors R4 and R6 protect the 8038 from damage that might be caused by extreme settings of R5 and R7. Resistor R8 is used to adjust the oscillator for minimum sinewave-distortion.

The input buffer/amplifier is IC2, a 741 op-amp that supplies a signal whose level is high enough to drive most of the devices likely to be tested. As configured, it provides a signal whose level can be varied from a few millivolts to 3 volts peak-to-peak. Short circuiting the output will cause no problem because of the presence of R11.

The output buffer/amplifier, IC3, is another 741 whose input is the output of the device being tested. Capacitor C5 blocks any DC signal-component that may be present. Diodes D1 and D2 protect the op-amp from overstrong input signals. Resistor R14 is used to set the meter to 0 dB at the 1-kHz reference frequency so that deviations from that level can be measured. The meter accepts an AC signal and gives a reading calibrated in dB.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified
R1—33 ohms
R2—5000 ohms, potentiometer, linear taper
R3—30,000 ohms
R4, R6—2000 ohms
R5, R7—20,000 ohms, trimmer potentiometer
R8—100,000 ohms, trimmer potentiometer
R9—100,000 ohms
R10—220,000 ohms
R11—2200 ohms
R12—1000 ohms, potentiometer, log taper
R13, R16—10,000 ohms
R15—91,000 ohms

Capacitors
C1—0.12μF, 2%
C2—0.012μF, 2%
C3—0.0012μF, 2%
C4—0.47μF
C5—1.5μF
C6, C7—100μF (optional)

Semiconductors
IC1—8038 variable frequency oscillator
IC2, IC3—741 op-amp
D1–D8—1N914
M1—audio VU meter calibrated in dB. 1-volt RMS (or less) full scale, 2000 ohms (or greater) coil resistance
S1—SP3T rotary
J1, J2—RCA phono jack

Miscellaneous: power supply (±15 volts, 40 mA, 1% or better regulation), construction board, enclosure, hardware, etc.

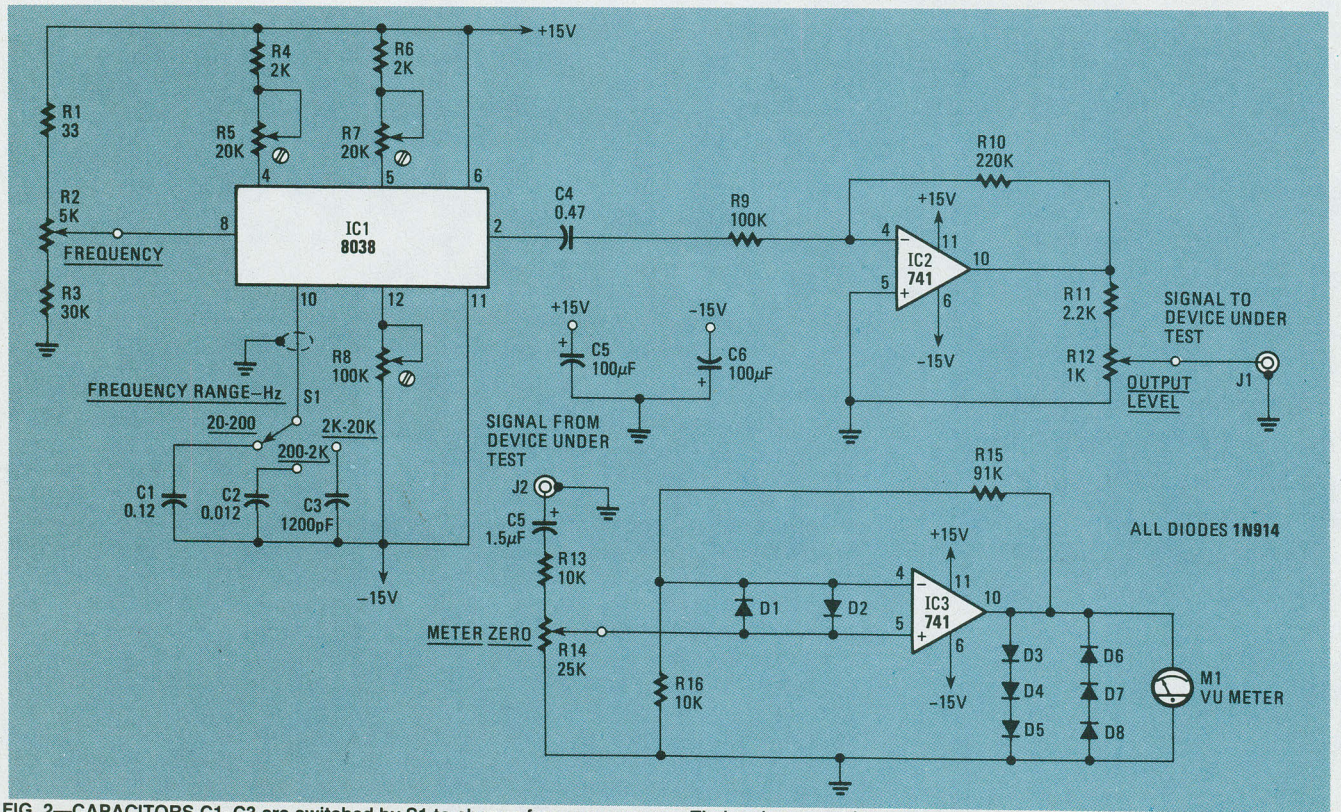


FIG. 2—CAPACITORS C1–C3 are switched by S1 to change frequency ranges. Their values must be accurately matched.

Diodes D3 through D8 protect the meter from being "pegged" with excess force.

The power supply is not shown, but any supply capable of delivering ±15 volts at 40 mA, with 1% or better regulation, will suffice. Good regulation is a necessity because voltage fluctuations will affect the accuracy of the frequency calibration.

Construction

Figure 3 shows how the front panel was laid out. The prototype was built in a 4½ × 4½ × 10-inch metal box, but a variety of boxes and cabinets are available and can be used. An attractive cabinet that can be displayed with your stereo equipment should be considered.

The circuit can be built on a variety of board types. The most common and easy to find are those which hold 0.1-inch spacing DIP (*D*ual-*I*n-*L*ine) packages. Just make sure that the board is large enough to hold the three IC's, two trimmer potentiometers, and the other components. Wire wrap or point-to-point wiring techniques are acceptable; the prototype used point-to-point wiring, as can be seen in Fig. 4.

A 22-pin connector was used to connect the front panel to the circuit board. That probably represents an unnecessary expense, as there are only five wires to connect to the panel and three to the power supply.

Figure 5 shows the component layout on the circuit board and on the front panel. Wiring to the 8038 is not critical unless you want to add another range to go above 20 kHz. In that case, the leads from pin 10 of the IC must be kept as short as possible.

If your power supply is more than a foot away from the rest of the circuitry, you should add a 100 μF capacitor from each power-supply line to ground at the circuitry (that's shown in the inset in Fig. 2).

Wiring to the 741 op-amps is not critical except for the wires attached to the inverting inputs (pin 4), which should be as short as possible. (That means that R9, R10, R15, R16, D1, and D2 should be within an inch of their respective IC's.)

Adjustments

If you have access to 1% or 2% capacitors, use them for C1, C2, and C3. However, precision capacitors are quite expensive. If you have a digital capacitance meter, you can use it to check lower-tolerance devices until you find values close to those required. You may have to add small capacitors in parallel to get the proper values. The exact values of C1–C3 are not important, since R5 and R7 are used to set the frequency. What *is* important is that the capacitor values be as close to exact multiples of each other as possible. For example, values of 0.15 μF, 0.015 μF, and 0.0015 μF (instead of the values shown in Fig. 2) would be quite acceptable.

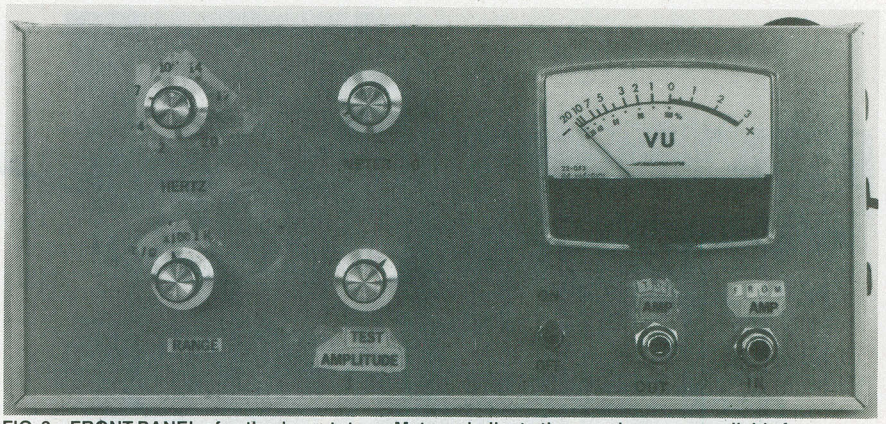


FIG. 3—FRONT PANEL of author's prototype. Meters similar to the one shown are available from many of this magazine's advertisers.

If you do not have precision capacitors or a digital capacitance meter, all is not lost. All you have to do is measure the frequency of the oscillator as you switch from one range to another. If the frequencies are not exact multiples of each other, simply change (or make up parallel combinations of) capacitors until they are. The frequency measurements can be made using a digital frequency counter or an oscilloscope.

Adjust resistors R5 and R7 to obtain a symmetrical (i.e., not bent over to the side) sinewave of the proper frequency. To perform the adjustment, set R2 all the way counterclockwise. Set switch S1 to the 2KHZ–20KHZ position. Adjust R5 and R7 as many times as necessary until you get a symmetrical 2-kHz sinewave. (You'll find that each resistor seems to adjust half of the sinewave.) You'll need an oscilloscope (and ideally a digital frequency counter, as well) for that operation.

Resistor R8 should be set for minimum sinewave distortion. An oscilloscope is adequate for doing this, though a distortion analyzer would be better. If you're not sure of what to look for, compare the oscilloscope trace with a picture of an "ideal" sinewave in a magazine or book so you can recognize the proper shape.

The FREQUENCY potentiometer, R2, has to be calibrated and labeled. First, turn it completely counterclockwise. Then set the RANGE switch to the 2KHZ–20KHZ position. Verify that R5 and R7 are adjusted correctly by checking for a symmetrical 2-kHz sinewave at J1. Mark that position of the FREQUENCY control with a "2." Turn the control until your counter or oscilloscope indicates a signal with a frequency of 4 kHz. Mark the panel at that position with a "4." Perform similar calibrations for 7, 10, 14, 17, and 20 kHz, and mark the dial settings for frequencies between those points with dots. Finally, verify that the calibration is accurate on the other frequency ranges. (It should be if you chose your capacitors carefully.)

Operation

To measure the frequency response of a preamplifier or power amplifier, connect jack J1 of the response meter to the input

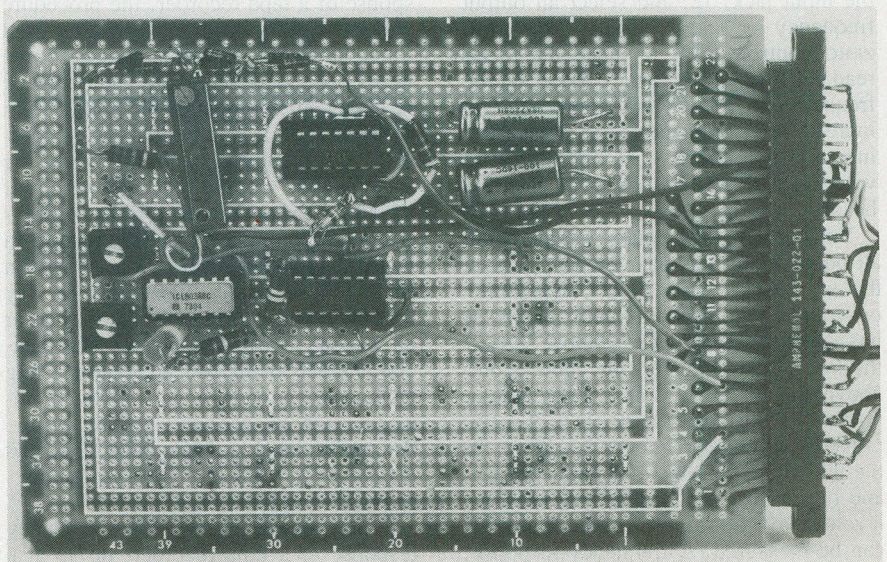


FIG. 4—ALMOST ANY TYPE of construction can be used. Leads of frequency-determining components should be kept short.

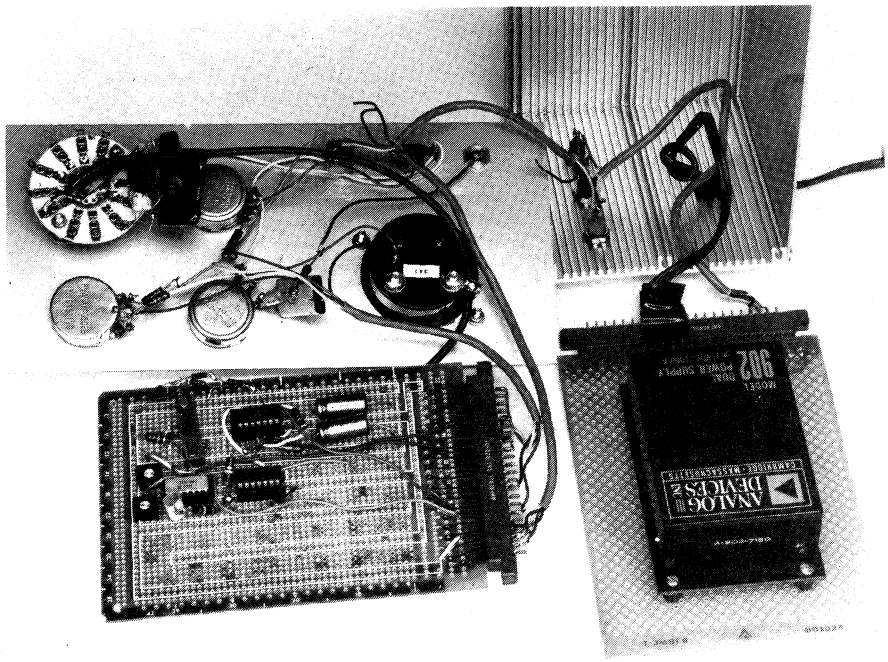


FIG. 5—REAR OF FRONT PANEL is seen above circuit board. Power-supply module is at right; it should be well regulated for accurate results.

jack of the amplifier. Adjust the output level control (R12) for a signal of the proper amplitude. That amplitude will depend on the signal requirements of the amplifier-input being used. If the amplifier being tested has built-in meters, they can be used to determine the proper amplitude. If there are no meters, you can listen to the signal through a speaker or earphones to verify that the level of the test signal is neither too high nor too low. A signal that's too high in level will sound distorted; one that's too low will be hard to hear and will sound noisy. Using an oscilloscope connected to the output of the amplifier is an excellent way to judge signal amplitude and distortion.

Connect the output of the amplifier to the input jack, J2, and select an output frequency of 1 kHz. Adjust the METER ZERO control, R14, to make the meter read 0 dB at that frequency. Then, set the frequency to 20 Hz and slowly start to increase it. At some point the meter reading will rise from −20 dB (which is where it will probably be at 20 Hz) and head up toward 0 dB.

You can note the frequency response at all points along the way, or simply note the −3-dB or −6-dB points, depending on your requirements. If your amplifier has a response that extends below 20 Hz, the meter will indicate it by starting out above the −20-dB point. You should sweep through the entire 20-Hz to 20-kHz range, noting the frequency response all the way up. The effects of tone controls and filters (scratch, rumble, and subsonic) on the overall response of the amplifier can be measured. A frequency-response test for each new switch setting can be run in about two minutes.

To check the operation of your frequency-response meter, connect its output to its input. You will, in effect, be measuring the frequency response of a piece of wire, the connecting cable. If there is any variation from a perfectly flat response, you should try to find out why. The most probable cause will be an inaccurate (non-linear) VU meter. A ±½-dB accuracy should be easily obtained. Good sources of VU meters are old stereo-equipment, surplus outlets, or parts catalogs; check the ads at the back of this magazine. A final word of advice: If you can see the pointer of the meter vibrating at frequencies below 30 Hz, don't be concerned—that's normal.

If you are measuring the frequency response of a tape recorder, the procedure will be slightly different from that used for an amplifier. If the recorder has three heads (i.e., separate record and playback heads), you can monitor the output from the tape and measure the overall record-playback response in pretty much the same way as you did for an amplifier. If the recorder has only two heads, however, the process will take a little longer. In that case you must record a tone of a given frequency, rewind the tape, and then play it back. If the recorder has a tape counter on it, you can record a series of frequencies and play them back all at once, using the counter to keep track of which frequency was where on the tape. Automatic-level controls must be turned off when you make your frequency-response measurements.

When measuring the high-frequency response of a tape recorder, do so at a level that measures about 12-dB below the maximum on the recorder's VU meter; otherwise you'll overload the recording circuitry. Recorders respond that way because normal speech and music contain relatively little high-frequency information, and the internal response curve of a recorder is such that it would be overloaded if a high-frequency signal at a level of 0 dB were applied to its input.

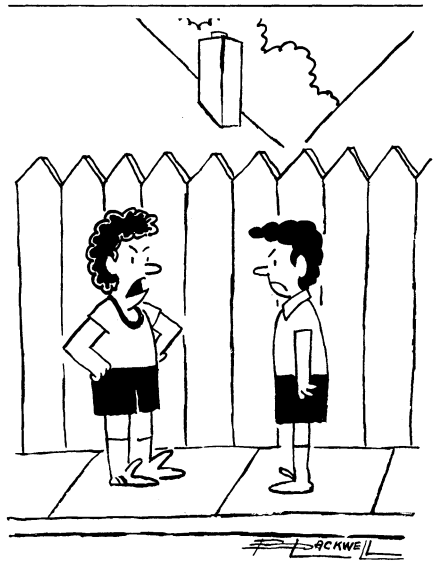
If a recorder has bias and equalization controls, you can use them to get the best possible response for a particular brand or type of tape. You should try several different ones to find which are best suited to it.

Modifications

The frequency range of the response meter's oscillator can be extended. With the selection of the appropriate capacitors, 1 Hz–20 Hz and 20 kHz–200 kHz ranges can be added. High values will produce low frequency ranges, and vice versa. A lower frequency-range will also require increases in the values of capacittors C4 and C5.

The triangle- and square-wave outputs of the 8038 can be made available as outputs on the front or side panel. The squarewave output of the IC can be used for risetime measurements, while the trianglewave is useful for slew rate measurements. It's a good idea to buffer those outputs the same way the sinewave output is buffered. Also, using the squarewave output of the 8038 often produces spikes in the sinewave input. If that happens, you may want to install a switch to disconnect the squarewave function when it is not in use.

The ability to measure frequency response is quite useful when choosing recording tape, checking recorder headwear, setting tone and filter controls, or adjusting a graphic equalizer. Most stereo components and audio test equipment can be evalutated in minutes with the use of the inexpensive instrument described here. **R-E**



"Oh, yeah? Well my *home computer can beat* your *home computer!"*

Radio-Electronics

VIDEOGAMES

VIDEO GAMES

Videogames 1983
Handheld/Tabletop Games
Games That Talk
New Software & Add-ons
Atari ★ Coleco ★ Starpath ★ Vectrex
R-E's Top Ten Videogames

There are those who say that videogames are on the way out. Judging from what's coming this year, though, that's far from being the case.

DANNY GOODMAN

VIDEOGAMES '83

IF YOU THOUGHT HOME VIDEOGAMES WOULD SIMPLY FADE away as home computers became more popular, you may have to reconsider. Atari and Coleco sparked the industry last year with two new high-resolution game systems. And, from the looks of this year's new system introductions, home videogames may hold their own for some time to come.

Mattel Electronics has redesigned and lowered the price of its *Intellivision Master Component*—now called *Intellivision II*—while showing a broad line of add-ons. Also in the wings is *Intellivision III*, a supergame to appeal to the high-end game market. Over at Odyssey, the price of the venerable *Odyssey*^{2} has dipped below $100, and a second, more capable system is in the offing—the *Odyssey Command Center*.

Intellivision II

The Mattel Electronics home-video product line seems to have exploded overnight. From one *Intellivision* console, one *Intellivoice* speech-synthesis module, and a modest cartridge library, the company has shifted into high gear with a compatible and intelligently upgraded *Intellivision II*, plus a series of modules featuring speech synthesis, Atari-*2600* cartridge compatibility, computer-keyboard capability, and music synthesis.

Having learned from its experience with the original *Intellivision Master Component*, Mattel endowed the new console with several notable improvements. The small addition of a red LED pilot light on the unit will save countless players from leaving the game on overnight—frequently a fatal mistake for the unit, especially if the console is left on a carpet that blocks some of its ventilation holes.

Hand controllers have been restyled to match the console's cosmetics, but are functionally identical, except that the cords are now terminated in a plug and stretch out farther. If a controller goes bad now, you'll be able to replace it without taking or sending the entire unit to a repair center. That also leaves open the possibility of adding a joystick controller for games in which the flat direction-disk is clumsy.

NOT JUST A VIDEOGAME. When used with an optional telecommunications module, the Odyssey *Command Center* offers computer terminal capability.

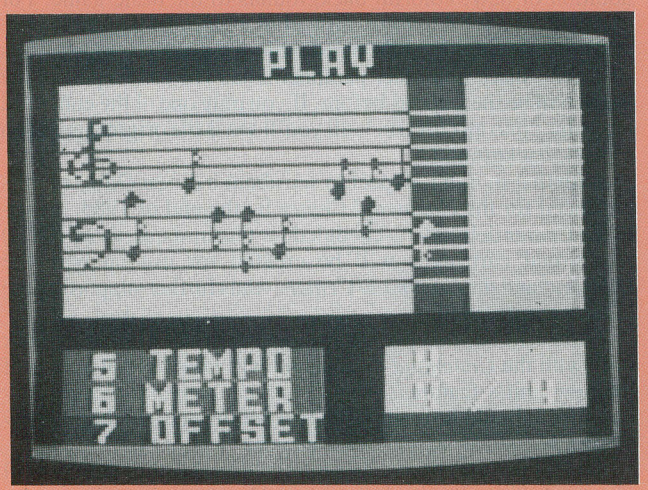
Luckily for both old and new *Intellivision* owners, game cartridges are compatible with both systems. That means that original *Intellivision* owners will be assured of being able to play the new cartridges as they become available for the *Intellivision II*. Also, *Intellivision II* buyers have a fairly large library to choose from immediately.

As expected, a re-styled *Intellivoice* speech-synthesis module plugs directly into the *Intellivision II*. The module is compatible with the original console, as well, but frankly, the light-gray and red, modern-looking box will look odd sticking out of the brown-and-walnut-finish cabinet of the old one.

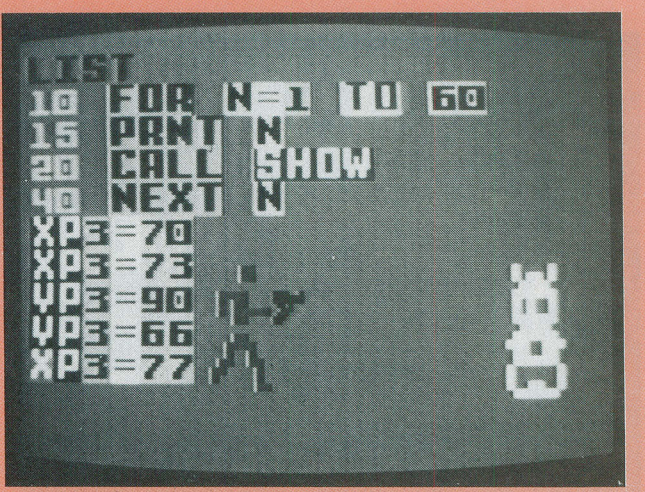
An unexpected but welcome add-on is called the *System Changer*—an adaptor that lets you play Atari *2600*-compatible cartridges. Two game-controller jacks are provided on the adaptor, so you can use the Atari controllers, or any of the dozens of accessory controllers on the market. Unfortunately, the Atari adaptor is not directly compatible with the original *Intellivision* console; a factory modification costing $19 will be required. The conversion will be worth it, however, if you plan to hold onto your *Intellivision* for a while. It is one way to get a second system—one with almost 200 cartridges to choose from—for less than the cost of a new system.

Next Mattel bridges the videogame-computer gap with another add-on, the *Computer Adaptor* and its companion keyboard. The adaptor adds 12 kilobytes of ROM (*R*ead *O*nly *M*emory)—which also contains a BASIC language interpreter—and 2K of RAM (*R*andom *A*ccess *M*emory) which may be allocated to enhanced graphics capabilities with new software. The *Computer Adaptor* can be upgraded by yet another cartridge that contains 8K of ROM (with an extended BASIC) and 16K of RAM for more computer-like applications. For programming and educational games, the keyboard offers 49 pushbutton keys in a standard QWERTY layout, although the locations of some keys—CONTROL and those for cursor movement—are not where experienced computerists would look for them.

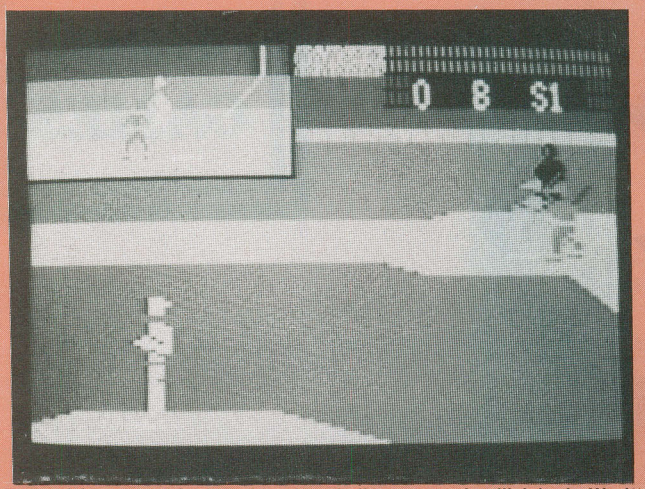
In place of the computer keyboard, you can plug in a four-octave music keyboard. By combining the powers of *Intellivision II Master Component* and *Computer Adaptor*, a remarkable six voices are at your disposal. Three software cartridges are planned for music alone, the most impressive of which is tentatively called *Melody Maker*. With it, you can use the keyboard to create and record up to six musical voices for playback later, along with a display of the actual music notation on the screen. While playing back a selection, you can easily alter tempo,



WITH THE OPTIONAL *Intellivision* music synthesizer, *Melody Maker* can be used to help you learn about and compose music.



IF YOU'RE NOT SATISFIED with the games available on the market, *Intellivision's Game Maker* helps you to create your own.



THE MOST TRUE-TO-LIFE video baseball game yet, Intellivision's *World Series Baseball* even offers split-screen views.

meter and key in real time. *Melody Maker* should be a great help to anyone trying to learn how to read music.

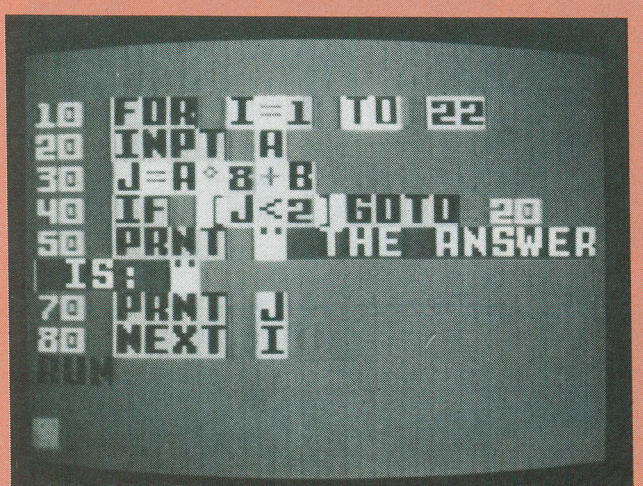
Other software planned for the *Computer Adaptor* includes BASIC language tutorials, elementary education activities with familiar cartoon stars like the Jetsons and the Flintstones, a three-dimensional strategy game similar to chess, and the now-famous baseball game (the one TV spokesman George Plimpton teased us with last Christmas) featuring TV camera-angles and split screens of the game action.

All the computer modules are fully compatible with the original *Intellivision* console without modification.

Intellivision of the future

That's not all Mattel has up its gaming sleeve. Scheduled for delivery late this year is *Intellivision III*, a do-everything game that will try to outperform *Colecovision* and the Atari *5200*. The published specifications are impressive. Graphics resolution is rated at 320 × 192 pixels (versus 256 × 192 for *Colecovision* and the *5200*). Up to 64 objects can be in motion on the screen at once (versus 32 and 5 for the Coleco and Atari systems, respectively). (By "at once" we mean every 1/60 second.) There's still more: six-voice music, built-in speech synthesis, stereo sound-effects, microwave wireless hand-controllers with tactile keypads and real joysticks, automatic antenna-switching, and multi-colored LED status-readouts. Look for most of the first cartridges to play up the improved graphics resolution with a number of three-dimensional screen simulations with receding corridors and *Zaxxon*-like views.

Compatibility is also a strong feature for the *Intellivision III*, which is capable of playing old *Intellivision* cartridges and can be expanded with modules for the *Intellivision II*, including the Atari *2600* cartridge adaptor, the *Computer Adaptor*, and the *Music Synthesizer*. Like Atari's *5200*, *Intellivision III* will be the high end of Mattel's line. *Intellivision II* will continue to be supported on its own. No price had been announced as we went to press.



ONE UNUSUAL FEATURE of Intellivision's *BASIC Programmer* is its color-coding of BASIC instructions.

Odyssey Super Game

The Odyssey folks in Knoxville, Tennessee haven't been napping, either. New for 1983 is the Odyssey *Command Center*, not simply a modestly priced high-resolution game (under $200, like *Odyssey*^{2} was), but a game with the flavor of a computer. Bearing no family resemblance to *Odyssey*^{2}, the *Command Center* nevertheless features a full typewriter-style keyboard, but this time with pushbutton keys. There are even ENTER, SHIFT, and CAPS LOCK keys where a computerist would expect to find them. A separate row of keys features math symbols, three "soft" (user definable) function keys (F1–F3), HALT, CLEAR, and RESET.

Joysticks have been redesigned and store within the console for a neater appearance when not in use. Another improvement is that joysticks are not factory-wired into the console, making repair or replacement easier. An expansion connector in the back will accept a small add-on voice module, a BASIC programming module, and others, including a communications interface (phone modem).

That's right—part of the "computer flavor" of the *Command Center* is its ability to become a home communications-terminal for access to consumer databanks like CompuServe, The Source and the Dow Jones services. Also planned is a computer-programming module housing a Z80B microprocessor and 16K of RAM. Suddenly it is clear why the *Command Center's* keyboard is more computer-like than *Odyssey*^{2}*'s*—the *Command Center* itself is more computer-like.

The *Command Center* is no slouch when it comes to graphics resolution, either. It is reported to have a resolution of 320 × 210 pixels, or greater than that of the *Intellivision III*.

For current *Odyssey*^{2} owners, the software compatibility news is pretty good, but somewhat complicated. First of all, any current *Odyssey*^{2} cartridge will work with the *Command Center*, with *Odyssey*^{2}-type graphics. Gradually, a number of the best selling *Odyssey*^{2} cartridges will be redesigned to take advantage of the added graphics capabilities available when using the *Command Center*. Essentially, the redesign will consist of the addition of new, colorful backgrounds to the basic game. For example, in *Pick Axe Pete*, instead of a black background there will be an inactive backdrop resembling the brown craggy walls of a mine shaft, and other paraphernalia. The action part of the game will be the same as before. If you plug one of the enhanced cartridges into an *Odyssey*^{2}, all you'll see is the original game on a black background.

With that in mind, expect to see about a dozen *Odyssey*^{2} hits enhanced for the *Command Center* by the end of 1983. (*Command Center* delivery is scheduled for the third quarter of 1983.) Additional cartridges will be created for use on both the *Odyssey*^{2} and the *Command Center*—thus further supporting the *Odyssey*^{2} into 1984.

There will be, however, new game cartridges that will work only with the *Command-Center* and will take full advantage of the new unit's features. About twelve *Command-Center*-only cartridges should be ready by the end of the year, including new deluxe *Master Strategy Series* games.

All that action by some big hitters indicates that there is still plenty of life to home videogames. Home computers are popular, to be sure, but serious computing and serious gaming just may not go together on the same equipment. **R-E**

VIDEO GAMES

NEW FOR COLECOVISION

Although it got off to a slow start, Coleco has recently shown a burst of energy and creativity that makes its new products worth watching for.

DANNY GOODMAN

IN THE PAST, VIDEOGAME-SYSTEM MANUFACTURERS WOULD introduce a console and a handful of cartridges to get the ball rolling, and then release a trickle of cartridges every several months. Early owners suffered from a lack of new challenges, and it took potential buyers a while to notice any growth in the variety of cartridges. It could be a couple years before you would legitimately be able to call the game selection a library. And, even then, all you'd have would be a console and a few cartridges.

That may still be true today for some companies, but not for Coleco. In the last six months of last year, the firm not only began shipping one of the most advanced videogame systems in the industry, but two expansion modules as well, along with cartridges containing the most popular arcade game titles at the time. In the succeeding 12 months—by the end of 1983—the Coleco system will have more state-of-the-art hand controllers, expansion modules, and computer add-ons than any other home game. That includes their *Expansion Module #3*, that will add a megabyte to *Colecovision's* memory.

Colecovision lives up to its claim of being a "third generation" videogame. Graphics resolution is equal to that of the best home computers, thanks to a Texas Instruments graphics-generator IC. It allows up to 32 different moving objects to be on the screen at once. The sound circuits are versatile enough to recreate arcade-game music and sound effects. Most importantly, the entire system was designed from the start to be expandable.

Console specifics

The *Colecovision* console's cabinet is a low profile, black plastic box with only two controls—an ON-OFF slide switch and a RESET pushbutton—both of which are flush with the cabinet. Two plug-in, coiled-cord hand controllers, when not in use, nest in separate bays, with only the joystick knobs extending above the case surface. There is ample room in the bays for the cords.

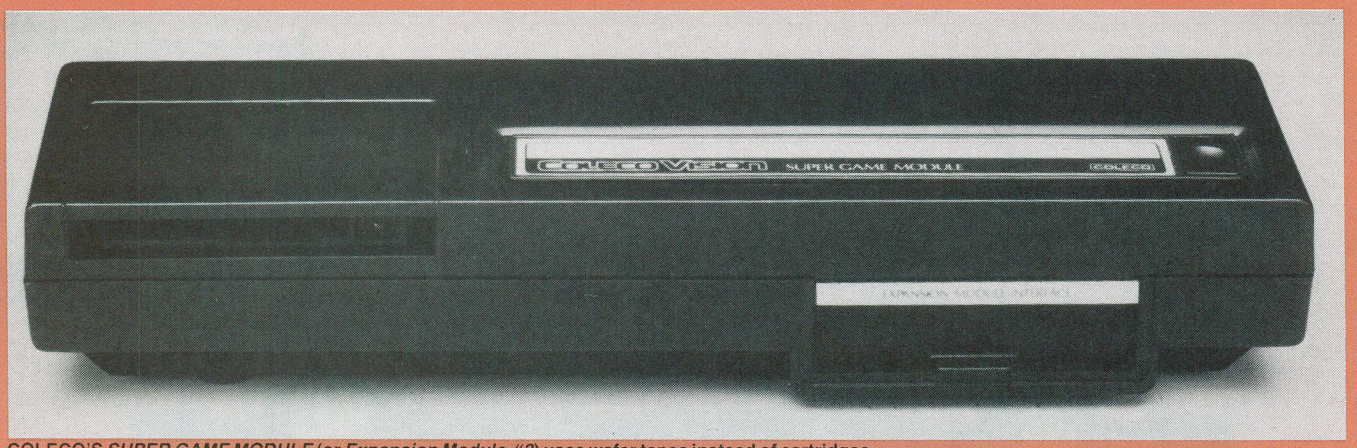
Power to the console is provided by a large wall-plug supply at the end of the power cord. While the transformer is apparently large enough to handle future console add-ons, having such a large and heavy box plug directly into the AC socket is awkward, since the box may also block access to another socket.

The procedure for connecting *Colecovision* to a TV set's antenna terminals is the same as that used for most videogames. A TV/game switchbox is included with the unit.

Colecovision cartridges plug into a top cartridge-slot protected by a hinged metal door that gets pushed out of the way as a cartridge is inserted. The door helps keep dust out of the circuit-board connector inside. On the front panel of the console is another slot with a sliding plastic door. That slot is where some of the expansion modules plug in.

Controller design

The standard *Colecovision* hand controllers have rightly been criticized for a couple of faults. For small hands—even small adult hands—they are awkward to hold. The body of the controller feels too wide for a comfortable grip. It would be accept-



COLECO'S *SUPER GAME MODULE* (or *Expansion Module #3*) uses wafer tapes instead of cartridges.

able if you only had to hold a controller with one hand, and let your other hand do all the action. But trying to use the side-mounted FIRE button is exhausting. And, when both fire buttons are used, cramps may set in. It is not unusual in a tense moment for the entire controller to pop out of your hands.

The joystick is also awkward. The big knob would be much more effective if the stick beneath it were longer. As it is now, you can't get the grip that you would expect from an arcade controller. For one-player games, you can plug in a more comfortable joystick—provided it is compatible with the Atari *2600*. You'll still need one *Colecovision* controller plugged in, because you need to use the keypad to select game levels and to restart games. There's an alternative, though—you can use Coleco's new super controllers (see below).

THE SUPER ACTION CONTROLLER gives you complete control over all the action.

A strong point of the controller is its numeric keypad. It's a touch-sensitive, membrane type, with each of the digits deeply recessed. Overlays, when needed, slide underneath the plastic grid. That way, you can feel your way around the keypad while keeping your eyes on the screen action—in sharp contrast to the *Intellivision* and Atari *5200* controller-overlays that make you look at the controller if you want to hit the correct key.

Adaptors abound

Coleco was the first on the market with an adaptor to accept Atari *2600* cartridges for play on a different system. The *Colecovision Expansion Module #1* is about one-third the size of the *Colecovision* console, into which it plugs via the expansion slot. The module has all the control switches used on the *2600* console handy. Two controller-jacks face the front (as they should on any console) for plugging in *Colecovision* or any *2600*-compatible controllers. With the expansion module installed, the *Colecovision* cartridge slot is disabled, and graphics resolution is the same as on the *2600*. While waiting for the *Colecovision* library to grow, players can take advantage right now of the nearly 200 cartridges on the market that are compatible with the *2600*. The module may also be an incentive for *2600* owners to upgrade to *Colecovision* without sacrificing a hefty investment in their *2600* software.

It is possible, however, that some *2600*-style cartridges may not work with the expansion module. Apparently, the cartridge-slot specifications for the module are not completely identical to those of the Atari *2600*. The difference is only a tiny fraction of an inch, but some cartridge cases (and the Starpath *Supercharger*) prevent all the contacts from making proper connections to the *Colecovision* adaptor. Coleco is working with *2600* software developers to make sure that won't happen in the future. Starpath, for one, is including a special extender with each *Supercharger* for use on the *Colecovision* adaptor.

Expansion Module #2 is a unique driving controller designed to convey the arcade realism of driving games like *Turbo*. Surprisingly, you can really get both hands on the steering wheel. A wired-remote foot pedal is your throttle. One of the hand controllers fits securely in the module at a convenient angle so its joystick can be used as a gearshift. Packaged with the module is the *Turbo* cartridge, a home version of a successful arcade game by Sega. Another driving game, *Destruction Derby*, is scheduled for introduction this year, with more on the drawing boards.

If you were already impressed by *Colecovision*'s fidelity to original arcade games, you'll be blown away by the capabilities of *Expansion Module #3*, planned for release this summer. The $125 add-on makes *Colecovision* the first videogame system to use a small magnetic tape format called wafer tape. Small cassettes contain very narrow recording tape that can transfer computer data much faster than typical computer cassette-recorders. That lets a game designer break up a very long program into sections. As the game progresses to new screens,

the tape quickly loads the screen information into the console.

Coleco can now offer a *Super Donkey Kong* wafer that not only plays all four screens of the arcade original (as opposed to three in the cartridge version), but throws in the amusing interludes between screens. And because the wafer is also a recording medium, all-time-high scores are stored even when you turn off the game. Wafer titles planned for later this year are *Super Donkey Kong Jr.*, *Super Zaxxon*, *Super Turbo*, *Super Smurf*, *Super Sub Roc*, and others.

A roller controller is new for 1983. Made popular by a number of arcade hits like *Missile Command* and *Centipede*, a roller controller gives the player 360-degree control of the central character or cursor around the screen, with a velocity that varies depending on how fast the ball is spun. Coleco's adaptation is a separate console with slots for the two standard hand controllers. An important added design feature is that FIRE buttons are integrated into the roller panel, making it more closely resemble an arcade control panel. The first cartridge to employ the roller is a licensed game called *Slither*. Only games designed for the roller will benefit from its action, but more such cartridges are promised.

Super controllers

For something completely different, Coleco has "one-upped" everybody with a set of *Super Action Controllers* that gives you more control over the action than any other hand controllers around.

Packaged with a TV-camera-angle baseball game, the new controllers feature four buttons on the grip, a 10-button raised keypad (in a 2 × 5 arrangement), an easily grasped joystick, and a speed roller. With so many controls at your fingertips, very realistic play is possible. For example, in baseball, the defense can shift individual outfielders. On offense, the base runner can move at different speeds, according to how fast the roller is spun. Two more cartridges for the *Super Action Controllers* are scheduled for the immediate future—*Contact Football* and *Rocky Battles The Champ*, based on the movie hits.

Further expansion modules are planned for this year, including a computer-keyboard expansion, details of which Coleco will not release until it is formally announced.

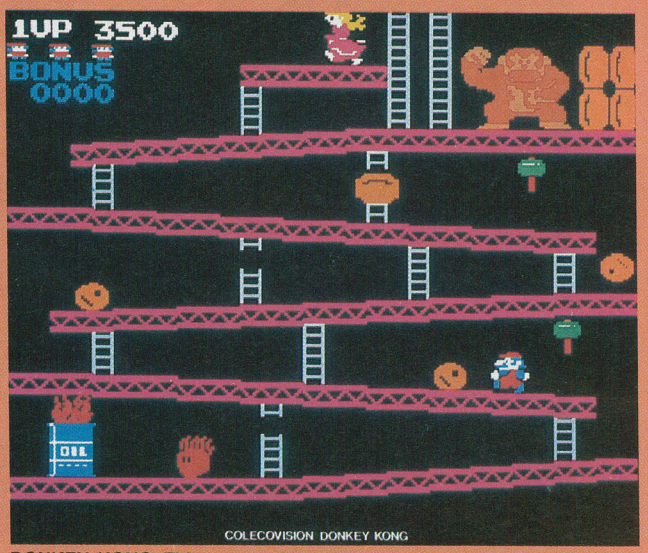
Software

Each time you plug in a new cartridge and turn on the console, a title screen appears for about 15 seconds. Then you are presented with a computer-like menu that supplies the game options available to you. Most games offer eight choices: four skill-levels for one or two players. Pressing the appropriate digit on either controller keypad starts the game. To replay the game, you need only press the star ("*") button on the controller, or the pound ("#") button to select a different game option from the menu.

Because *Colecovision* is targeted first toward the arcade-game crowd, it is not surprising that the company would choose a classic arcade hit game as the cartridge to be packaged with the console—*Donkey Kong*. Although there are minor flaws in the program that only experienced gamers will detect after considerable play, the *Donkey Kong* designer (perhaps "translator" would be a better term) has brought the true flavor of the arcade game to a home version. The graphics are crisp and finely detailed. Successful players are treated to three different screens of play, of which the third is an intense challenge even for experienced players. The home version is every bit as good a contest as the arcade original.

Zaxxon is *Colecovision*'s most expensive cartridge (about $50). The home version doesn't have quite the high resolution pizzaz of the arcade original—the variety of ground targets is much more limited—but players will still get the banking and flying feeling while guiding the jet over the floating space cities. As in the original, there are two cities and a free-space battle in between. Experienced players will find the *Zaxxon* robot scene easier to reach than in the arcade version of the game, but successive levels require more hits of his missile to be successful. Also at higher levels, some of the ground targets shoot sideways at you when you least expect it. The home version also lets you experiment freely with the altitude indicator at the screen's left edge in squeaking through tiny passages in walls guarded by deadly rays—where most quarters are lost.

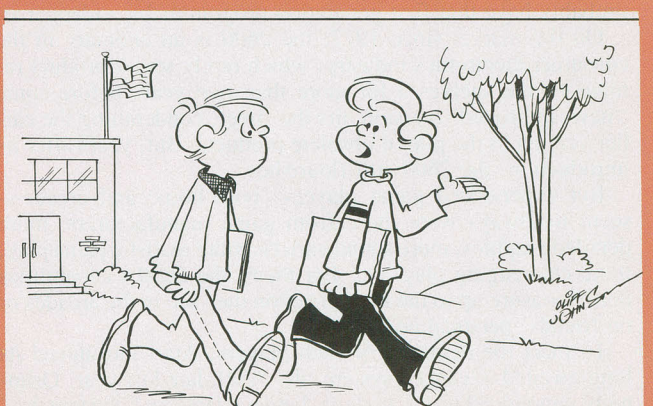
VIDEO GAMES



DONKEY KONG. **This true-to-the arcade version is packaged with the *Colecovion* system.**

Other new arcade cartridges for 1983 include: *Donkey Kong Junior*, *Looping*, *Gorf*, *Wizard of Wor*, *Pepper II*, *Mr. Do*, *Space Panic*, *Victory*, *Space Fury*, *Wild Western*, *Frenzy*, and *Buck Rogers' Planet of Zoom*. Another Smurf cartridge is planned for the kids, as are a role-playing game called *Tunnels and Trolls*, and *Horse Racing*, *Blackjack/Poker*, and a game based on Count Dracula.

It's one thing, of course, to promise great products, and quite another to actually deliver. So far, though, Coleco has racked up an admirable track record in living up to its *Colecovision* system promises. That makes the future of *Colecovision* all the more exciting to watch. **R-E**



"Talk about pressure and tension...I don't mean in school, but trying to stay on top playing all the video computer games!"

ATARI 5200

With its high-resolution graphics, advanced controllers, and expansion capabilities, the Atari 5200 offers twice as much as the 2600, in more ways than one.

DANNY GOODMAN

THERE ARE A FEW PRODUCTS THAT HAVE HAD SUCH A DRAMATIC impact on the marketplace that either their brand names or the names of their manufacturers have become synonymous with the industry as a whole. How many of us cover a sneeze with a Kleenex, have a Coke with our lunch, or make copies on the office Xerox machine?

Atari hasn't had quite that kind of impact—at least as of now; still, thanks to its superior marketing and large game library, when most people think of videogames they think of the old reliable *2600*. Exact figures are hard to come by, but as many as 75% of the 15 million households that have videogame systems, probably have that first-generation programmable videogame.

On the market since 1977, the *2600* is an anomaly in the consumer-electronics industry, which rarely sees a product remain on the shelves a for more than two years before some "new, improved" version hits the street, condemning the earlier version to the pile of obsolete products. But, years after its introduction, the *2600* still flourishes.

But experienced game players—both home and arcade—seem to always want more from game manufacturers: more detailed graphics, more sound variety, more realistic game play, more challenging play, etc. For them, the *2600's* capabilities don't measure up to the kind of action they see in the arcades or on friends' personal computers.

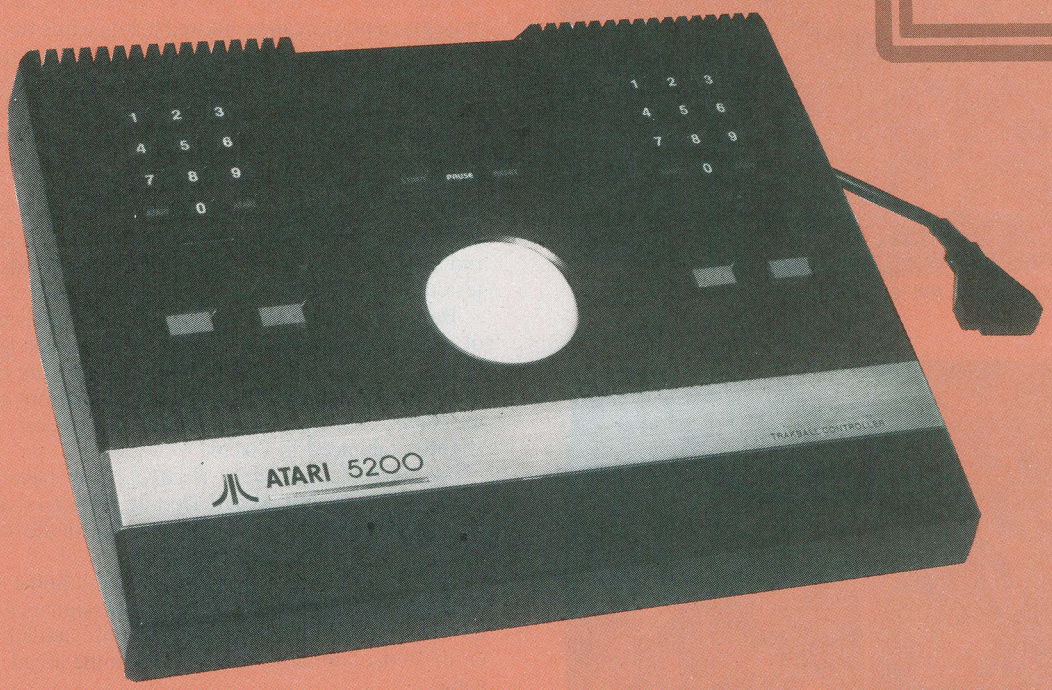
To meet the demands of such players, Atari introduced its long-awaited advanced system, the *5200*, late last year. Originally announced to the trade in January 1982 as "System X," the *5200* was under development quite a long time before Atari decided on an official name. One inside Atari source claimed that the unit was officially nameless even during its early stages of production. That the machine's final name is a number that is equal to *2600* × 2 would lead us to believe the new unit offers twice as much as *2600*. In many cases that is true.

Good looks

While it may be difficult to think of a videogame as being "professional," the *5200* without question is the most professional-looking unit to generate a space invader on a color TV. The console is shaped like a gently sloping wedge, made out of black plastic with liberal trim including smoked plexiglass panels on the top surface and a brushed-aluminum band. The smoked panels and the brushed aluminum are protected in shipment from the factory by easily removable self-adhesive plastic sheets. Other than the trim, the only features of note on the top surface are the wide cartridge slot and a single ON-OFF pushbutton.

The console is not small, measuring 4¼ × 15 × 13 inches, and therefore takes up quite a bit of space wherever you set it up. And while it is undeniably attractive, unlike its durable brother, this system's console may not take well to careless children—the plexiglass and brushed-aluminum surfaces are more susceptible to scratches and other damage then the *2600's* tank-like case. But overall, the *5200* is the prettiest game around to look at, even when it's off.

One advantage Atari had in developing the *5200* that it didn't have when it developed the *2600* was feedback from players



ATARI'S *TRAK-BALL* controller gives the *5200* that arcade feel. It's a great improvement over the joystick supplied.

about hardware features they'd like to see. Just about every design oversight of earlier videogame systems has been corrected in the *5200*, and several interesting innovations have been included.

One less wire

Perhaps the biggest headache associated with owning any earlier home system is the unavoidable rat's nest of wires linking the console to AC outlet, TV antenna-terminals, and hand controllers—a minimum of four cables. And, there is the pesky switchbox that selects the TV input (either the TV-antenna or game) to contend with.

Engineers at Atari attacked the problem head on, coming up with an ingenious new switchbox that manages to eliminate one of the wires to the console as well as the manual switch. In the new setup, the switchbox is an active component. Power from the AC transformer goes to the switchbox. From there, power passes to the console along the same cable used to convey the video output to the switchbox. Excess cable between console and switchbox can be wound around a recessed channel under the console. The real magic, however, comes when you want to play a game. When you press the console's ON-OFF button, the switchbox electronically selects the game input. When you're through playing, press the ON-OFF button again, and the switchbox selects the TV antenna. Nothing could be easier.

Of course, the custom switchbox arrangement means that you must use Atari's box, even if you have a fancy video switcher.

A brief word about the power transformer. Following the sensible example set by its *400/800* computers, Atari places the actual transformer box midway along the power cable. The advantage to that over the more standard wall-plug-type transformers is that a transformer of ample size can be used without too much concern about the space it takes up. Otherwise, the wall-plug unit is likely to take up so much space at the AC socket that access to the other sockets is hindered—sockets that are needed for such things as your TV, VCR, and so on.

Another nice feature of this system is that you don't have to remember to turn off the console before changing cartridges. That is a convenient feature to be sure: Although most experienced game players are by now conditioned to turning off the power first, many of their friends and neighbors are not. Pulling out a *5200* cartridge causes the screen and sound to go blank but will not cause damage to either the cartridge or the console. (Sometimes, though, when you re-insert a cartridge, a quick on-off cycle is needed to clear the screen of "garbage."

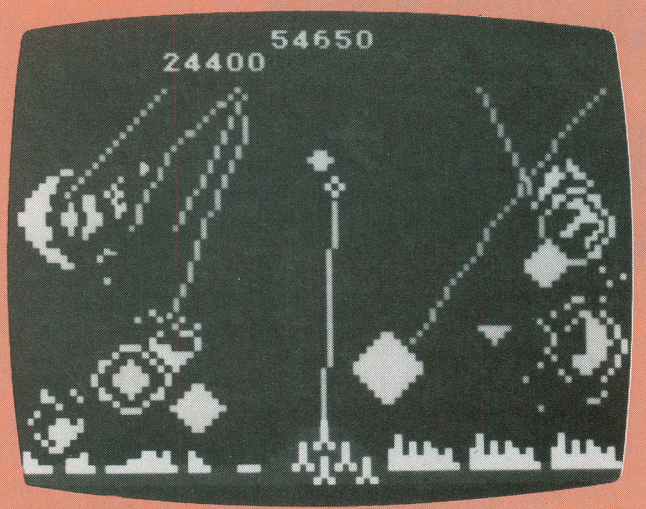
The console also has another feature that, although simple, could save you a couple of service calls. Due to the lack of any kind of on/off indication, all too often owners of almost every other system have come back to their unit only to discover that the game has been left on all night. That could prove fatal to a game, especially to units with inadequate ventilation. The likelihood of that happening is reduced in the *5200*, as it features a pilot light that glows whenever the unit is on.

Advanced controllers

Borrowing an idea from home computers, all four hand-controller sockets (ports) are located on the front of the console, closest to the players. That arrangement gives players much more effective cord length for the controllers.

But even more important is the controllers themselves; they look like they have a lot going for them, and they do, with the two exceptions noted below. They are, of course, all-in-one controllers, with both a joystick and twelve-button keypad. There are two FIRE buttons, called the upper and lower FIRE

A REALISTIC-LOOKING PLAYFIELD is the highlight of Atari's Soccer.



***MISSLE COMMAND* looks very much like the original.**

buttons, located on each side of the controller (to accommodate left- and right-handed players). The buttons are located close enough to each other so that repositioning your hand to hit either one (a drawback in the *Intellivision* controllers) is not required, and they are not so stiff as to cause discomfort during rapid firing.

A row of buttons along the top of each controller gives one player the ability to reset and start games without reaching for the console. A third button is the key to a helpful innovation—it lets the player pause at any spot in a game to answer the phone or plot a possible escape from impending destruction.

There is, however, one serious problem with the joystick—a problem that will be particularly troublesome for anyone who has played another videogame for any length of time. Unlike the joysticks for every other system on the market, these are not self-centering and, because of that, make the action on the screen hard to control. Problems with that design become very apparent in a number of games. For example, in *Star Raiders* you must carefully position a tiny cursor within a small box representing a sector of a galactic grid-map, but valuable time is usually wasted trying to keep the cursor steady. A self-centering joystick lets you gently nudge the cursor to the appropriate box. In *Super Breakout*, the cartridge supplied with the unit, the joystick provides nowhere near the level of precision offered by the *2600's* rotary paddle-controllers. Most of the problems will be solved nicely by the optional *Trak-Ball* controller, but Atari still should have made the joysticks more controllable.

Another disappointment is the keypad. At first touch, the keys have a nice "feel" to them, and it seems as though it might be possible to find your way to the right buttons without looking away from the action on the screen. (That's nearly impossible with the barely articulated bubble keys on Intellivision controllers.) But it doesn't take long to discover that the keypad overlays take you backward one step, by essentially converting real keys into flat membrane keys. In playing *Star Raiders*, in which swift interaction with the keyboard can make or break a mission, a player can be blasted to bits while fumbling to turn on his shields. Game play is often much easier if the key functions are simply memorized and the overlay discarded.

One really nice thing about the controllers is that they nest completely out of sight under a plexiglass panel when not in use.

Software Library

Because it is a new home videogame, the *5200* is somewhat light in the software department, but that status should change as more machines are sold. Initial offerings consist of eight time-tested arcade winners and a few sports games.

Because the circuitry of the *5200* resembles the Atari family of computers (the same 6502 microprocessor, graphics resolution, and sound generation) it's not surprising that most of the first cartridges to hit the market are adaptations of Atari computer games. They're not *exact* copies, however; they have been slightly enhanced in places.

For example, in *Super Breakout* you have the same four game-variations (Breakout, Double, Progressive, and Cavity), but each time you bounce a ball up to one of the bricks, the bricks dissolve, rather than just disappear.

Pac-Man is unquestionably the best home version of the all-time great. For the *5200*, Atari's designers took the already fabulous home-computer version and added humorous intermissions, similar to those found in the arcade version of the game.

Galaxian and *Missile Command* look very much like their arcade originals, while *Space Invaders*, although an exciting rendition, lacks the alien rocket ship along the left side of the screen found on the computer version. Other arcade titles include *Defender*, *Centipede*, and *Qix*.

Sports titles are limited so far, with high-resolution action available only for soccer, football, and baseball.

Independent cartridge-designers like Activision are keeping a close watch on sales of the Atari system to determine when (or whether) there will be enough units to make it worthwhile to design cartridges for the new machine. Imagic, however, has already announced its intentions to have *5200*-compatible cartridges available by Christmas.

Expandability

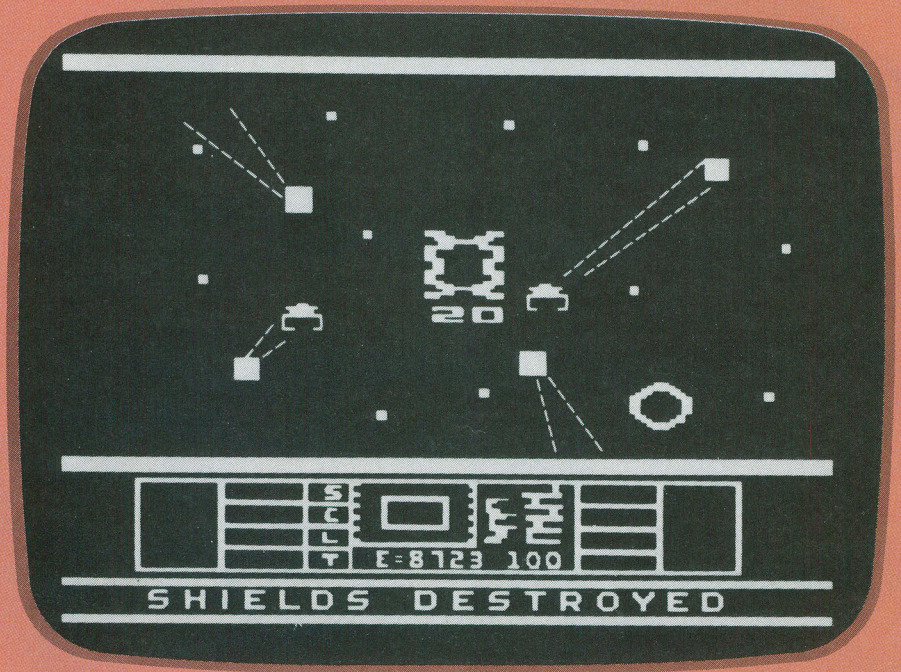
Among the features that are sure to draw gamers' attention is the fact that additional options will make the unit even more desirable in the future. The first option to come to market is a roller-ball controller that provides 360-degree directional control of the cursor or character on the screen. The *5200 Trak-Ball* controller features two sets of keypads and fire-button pairs (presumably to accommodate both left- and right-handed players). Of all the home roller-ball controllers available, that add-on has the most arcade-like feel and the largest surface area around it for controlled play even under panic game conditions.

Other accessories announced include a voice-synthesis module and a *2600*-cartridge adapter. Atari might have won over many of the gamers who chose *Colecovision* if that *2600* adapter had been ready from the beginning. That's because the only serious drawback that the *5200* has is the small library currently available for it.

The *5200's* $250 price tag is high, especially when you consider that you can buy an Atari *400* computer for about the same price, and there is a far larger game library available for the latter machine. But as add-ons and new, distinctive, software become available only for the *5200*, it may be one of the few systems to survive the computer gold rush of the 1980's. **R-E**

STARPATH'S SUPERCHARGER FOR ATARI

VIDEO GAMES



Perk up your Atari-2600-compatible videogame console with this new accessory. Its combination of added RAM and high-quality games is hard to beat.

DANNY GOODMAN

TO MOST OWNERS OF AN ATARI *2600* (OR AN ATARI-*2600*-compatible machine), the cartridge slot is simply where you plug in your ROM-based game cartridges. But to owners of Starpath's (324 Martin Ave., Santa Clara, CA 95050) new *Supercharger* unit, it is the launching pad for a new series of games that make the *2600* do a lot more than most game players would ever have thought possible.

The exciting new system offers a unique combination of features that include enhanced graphics and the ability to load games from cassette tapes; you can play more complex games than ever before on the *2600*, yet at a cost-per-game that's half that of its nearest cartridge competitors. By mid-year, Starpath (formerly called Arcadia) expects to have about a dozen games on the market; all are playable only through the *Supercharger*, which plugs into the cartridge slot on the game console. Besides offering the best graphics ever devised for the *2600*, a high percentage of the games are first-rate in their own right, pointing toward even greater things to come.

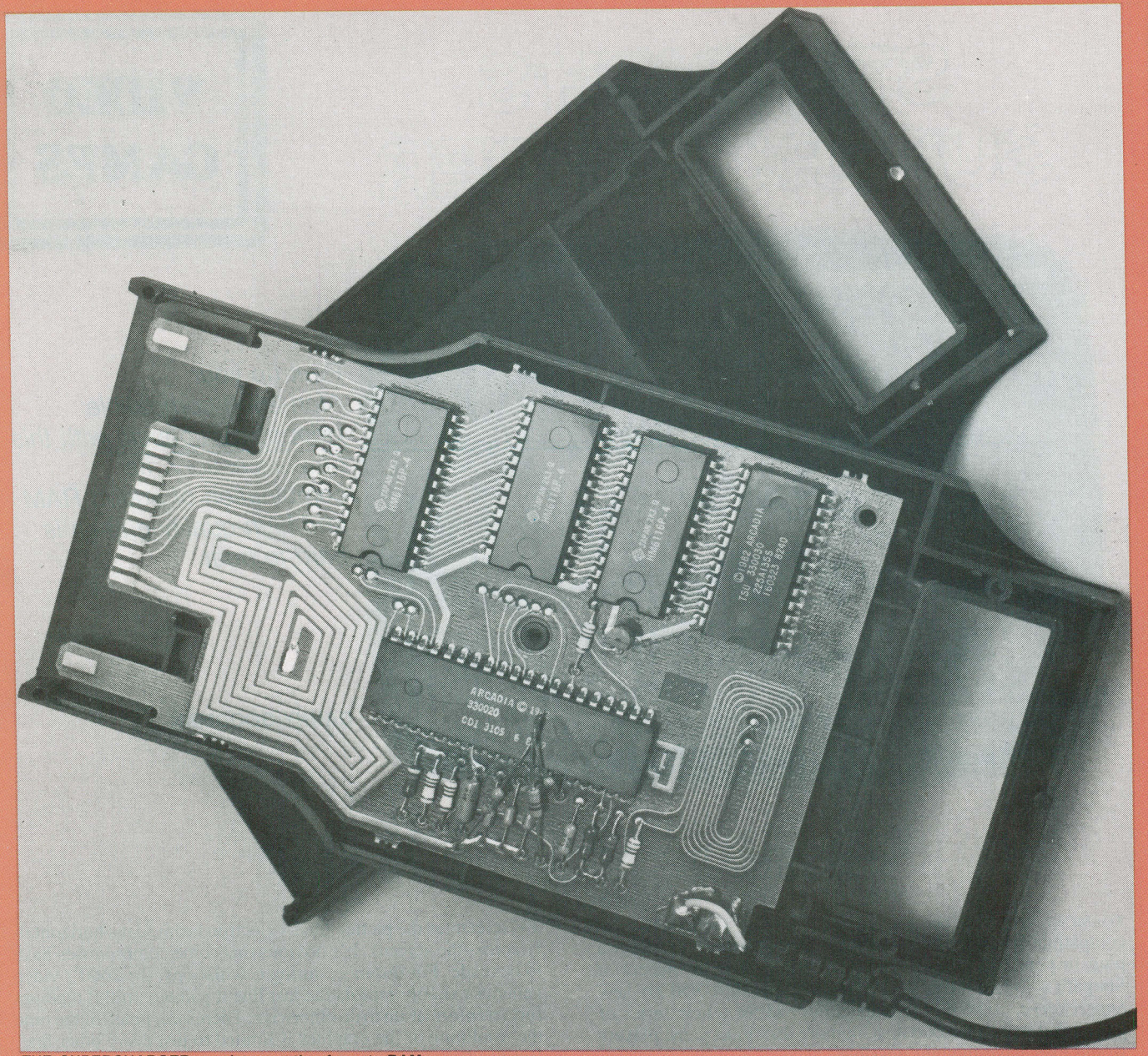
Atari graphics

To understand how the *Supercharger* works its magic takes a little knowledge of what goes on inside that Atari *2600*. The *2600* offers only 128 bytes of internal RAM (*R*andom *A*ccess *M*emory), some of which must be held in reserve to keep track of information like score digits, the number of turns left for each player, the instantaneous location of objects on the screen, and the like. That limited amount of RAM can sometimes be severely taxed, such as when the *2600* sometimes needs to perform a split-second calculation while a scene is being "painted" on the TV screen (as the picture tube's electron beam scans horizontally across the screen). It's obvious that some compromises have to be made. For instance, during calculations, the *2600's* video generator simply repeats the last line it painted until it receives further information to do otherwise. Therefore, much of the time the resolution of the graphics is limited to just every other line. But the *Supercharger* changes that.

Under normal circumstances, a game cartridge consists of ROM (*R*ead *O*nly *M*emory) that is factory-programmed to turn the *2600* into a *Missile Command* game, or whatever—the *2600* gets its instructions from the ROM in the cartridge. The *Supercharger*, on the other hand, consists primarily of empty RAM (plus some ROM containing factory instructions on how the system is to "behave"), and boosts the *2600*'s overall RAM capacity to over 6000 bytes. All the electrical power the *Supercharger* requires comes from the cartridge slot—a definite convenience.

To play a game, the game information (similar to the information contained in a cartridge's ROM) must first be loaded into the RAM. The procedure to do that is similar to the one used when loading a cassette-tape program into a personal computer—only easier. Games are downloaded through a 34-inch cable that is wired into the *Supercharger*. That cable is terminated in a ¼-inch mini phone-plug that can be connected to any cassette-tape recorder, even "walky-type" personal stereo-cassette players.

Unlike a computer, which requires typing some BASIC command on the keyboard (CLOAD for loading from a cassette, for example), the *Supercharger* prompts the user right on the



THE *SUPERCHARGER* consists mostly of empty RAM.

screen. Over a background of twinkling stars, the words REWIND TAPE and PRESS PLAY appear. In a few seconds the program begins loading into RAM. Vertical blue bars fill the screen during the 30-second load, indicating that everything is going smoothly. If an error crops up, the screen immediately reverts to the prompt messages for another try. Once the full program is loaded, the screen tells you to STOP TAPE. When you do, you see the title screen for the particular game you've loaded.

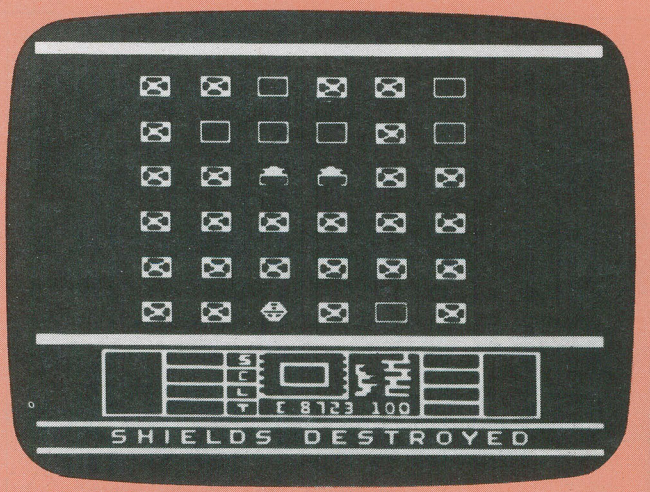
The bulk of the *Supercharger's* RAM is devoted to game-play information, taking the place of a cartridge ROM; but even so, more RAM is devoted to storing screen images than would be possible using the *2600* alone. The extra RAM allows the game system to perform any calculations needed during the vertical-blanking interval (the period during which the black bar you see when the vertical hold is misadjusted is scanned). Thus, information for a complete picture frame can be "read" without interrupting the screen painting. The result is a video image that can address individual horizontal scanning lines on the TV screen. Images are sharply defined and detailed, much more so than you would think possible using a *2600*.

Multiple-load games

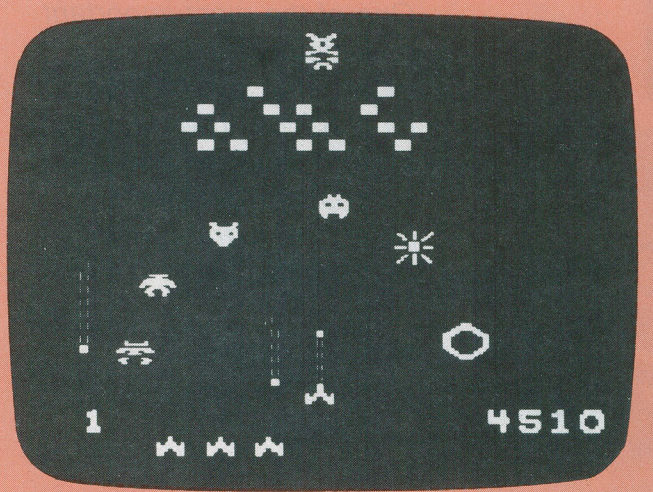
Cassette loading of programs into the game system produces an added benefit—increased game playability. A ROM-based program is limited in the variety of game play and/or the variation in screen displays—or "boards" as arcade gamers would call them—it can provide. The problem is that the *2600* can access only a small amount of memory (either RAM or ROM) at any given time. One method of building multi-level, multi-screen game play is to develop a series of cartridges that use knowledge from earlier games as the basis for further play. Atari is doing just that in its *Sword Quest* series, and Imagic is using a continuing theme in *Atlantis* and *Cosmic Ark*, with others perhaps to follow.

Starpath has a better solution: successive levels on multiple loads of the same cassette tape. *Escape from the Mindmaster* and *Dragonstomper* (one thing's for certain, this company has some of the most imaginative game titles on the market) were the first two to use that technique.

Escape from the Mindmaster is the first *2600*-compatible maze game to feature realistic three-dimensional effects; it appears as if you are really walking down corridors and through



***PHASER PATROL* is shipped with the *Supercharger*.**



THE ACTION IN *Communist Mutants From Space* is even better than its name.

doorways. That creditable job is the result of the *Supercharger's* high-resolution graphics that reduce to a minimum the "stairstepping" effect so noticeable on diagonal lines in the basic system.

The predominant game play is much like a psychological test of perception and memory. Scattered about a maze's dead-end alcoves are several shapes and the respective "holes" in which they belong. A radar screen gives you a better appreciation for the layout of each maze. First you must find a shape, pick it up with the action button (you can carry only one object at a time), and find its hole elsewhere in the maze. Press the action button again and the object flies up to the hole, and you can move on. In early levels, the shapes are easy to remember—a square, circle, etc.—but they get far more complex and similar as play progresses—some even resemble tinkertoy-like objects, for example. The locations of shapes and holes change each time you load the program so the game always presents you with a fresh challenge. When you've completed a level, you have to find a secret doorway that gets you upstairs to the next level. Each load of the tape contains two mazes, or a total of six mazes in all that must be solved in order to escape the Mindmaster. A fourth load contains a score and rating screen.

There's more to the game, of course. Another creature is also in each maze. If he touches you, you lose a "life." Fortunately, his movements are restricted to main corridors, and an audible alert lets you know whether he is near. If you're about to go through a doorway and the tone is high-pitched, you can be sure he's right on the other side of the door waiting for you. At higher levels, some interior corridors have deadly force-field panels flying by. You've got to time your passage just right and stop on a dime before the next one comes at you. Don't be fooled into thinking that, since you start with ten lives, you'll have no trouble getting to the top. It will probably take weeks before you make it to the third load.

When (*not* if) you lose all ten lives, you are instructed to PRESS PLAY on your tape player. The tape loads each successive level into the system, but the console knows that it must automatically continue to the last, the scoring level.

Also, in an alcove within the first five mazes is a game-within-a-game for a chance to earn bonus points. Each one is different—some are strictly hand-eye coordination tests, while others are reflex challenges or memory quizzers. Oh yes, they also help you forget where you may have seen shapes and holes you're trying to remember for later reference.

When you add up the superb graphic imagery of the hallways, good sound package (including the audible alarms), distracting sub-games, and far more board variety than possible from any other existing ROM-based cartridge, *Escape From the Mindmaster* ranks among the finest videogames on the market.

Dragonstomper

Another multi-load game, *Dragonstomper*, is a graphics adventure game with three complete loads. Each load level is a completely new graphics environment for your character. The first territory takes up about about six screens as the view scrolls around the "landscape." You do battle with a variety of enemies, picking up strength, gold, and other possessions along the way. Your interim goal is to acquire an identification paper, or enough gold to bribe the guard at the bridge.

The second load is a city. It is only one screen big, but there are four shops in which you can buy or trade possessions for supplies you may need in the last journey to the dragon. Once equipped with your supplies, you pass into a cavern where many dangers and hand-eye challenges await before you can meet that beast.

Typical of adventure-type games, the instructions are sketchy, leaving you to experiment with the effectiveness of your various possessions on the hazards.

As you can probably gather from those two examples, some Starpath games are not for the novice videogamer. The challenges are tough, and even the single-load games like *Fireball* and *Communist Mutants From Outer Space* are likely to hold the interest of even the veteran videogamer. The cassette packaged with the *Supercharger*, *Phaser Patrol*, is perhaps the best *Star-Raiders* variation available for any home game.

Not everything has gone smoothly for Starpath. It ran into a small obstacle in late 1982 when Coleco started shipping its *Colecovision* expansion-module for Atari *2600*-compatible cartridges. For want of a few thousandths-of-an-inch clearance in the adaptor slot, the *Supercharger* (and some *2600*-compatible cartridges as well) do not make complete connection. Starpath is now including a small extender for use with the adaptor. Owners of earlier units can obtain an extender at no charge, if they need one.

The good news for Atari *computer* owners is that Starpath is adapting some of its games for a single load into the computer. Games like *Escape From The Mindmaster* take up about 32K of memory, so only specially upgraded Atari *400's* (which come with a factory maximum of 16K RAM) or Atari *800/1200XL* computers can play them.

The bridge to computer software is not an unlikely move for Starpath. The company insists that although its first product was hardware oriented, it is not developing hardware simply for the sake of selling hardware. To reinforce that statement, Starpath recently reduced the suggested retail price of the *Supercharger* to $44.95, or slightly more than the list price of a top-of-the-line cartridge. When you consider that additional, deluxe games are available on cassette for only $15 to $17 each, it is clear that the *Supercharger* is a great value for the *2600* owner looking for more. Its combination of great games and great graphics is one that's going to be hard for any videogame system to beat. **R-E**

VECTREX

One of the most important considerations in a videogame is the quality of its graphics. The Vectrex system takes an unusual approach to providing images of extraordinarily high quality.

DANNY GOODMAN

RECREATING THE "ARCADE EXPERIENCE" HAS BEEN THE GOAL of several home-videogame manufacturers ever since the boom in arcade action caused by *Space Invaders, Asteroids,* and the unforgettable *Pac-Man*. However, the limitations of home color-TV receivers prevent full reproduction of the high-resolution color graphics used by the arcade machines, no matter how sophisticated the game or computer console hooked up to them.

One system, though, does manage a creditable job of bringing a genre of arcade-game display and action to the home versions of vector-scan games like *Asteroids, Tempest,* and *Reactor*. The game system is called *Vectrex*, and is manufactured by General Consumer Electronics, Inc. (GCE), a Milton Bradley subsidiary. To capture the arcade realism, the GCE folks had to equip the console with its own black-and-white video monitor. Yet, they managed to do that for under $200, with plug-in cartridges ranging in price from $30 to $40.

What the game player ends up with is an entirely self-contained, challenging videogame system that is no longer tied to a color TV in the home. Since GCE developed the entire system itself, it had the luxury of orienting the video monitor vertically, as are most arcade displays. That makes the *Vectrex* quite compact; it takes up little tabletop-space. Moreover, it is very portable. Since you need only connect it to an AC outlet, you can move the *Vectrex* anywhere.

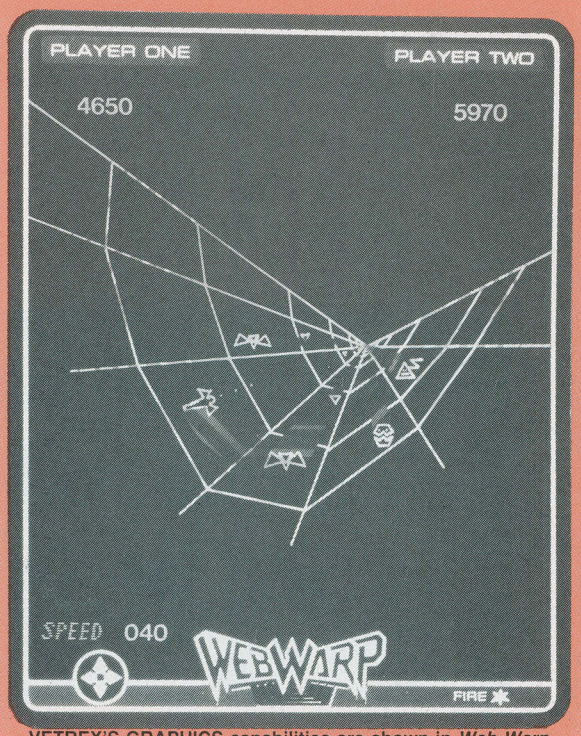
The vector-scan display

The *Vectrex* is the first home videogame to use a vector-scan display. Vector scanning does not rely on a series of raster lines—the basis for ordinary TV-screen displays—to create an image. Instead, the video images are practically "drawn" on the screen in outline form by the CRT's electron beam. No areas are filled in with color, but the outline shapes can be very high in detail. Objects can grow larger or smaller, rotate about one or more axes, and move smoothly about the screen, all without flicker. Although the video monitor is black-and-white only, color is added to every game by screen overlays supplied with each cartridge. The overlays are sturdier than what you may remember from the old videogame days. Back then—only about ten years ago—playfields printed on clear plastic had to be taped over the TV screen as simple flying dots or blocks responded to hand-controller movements. But with the *Vectrex*, a colorful transparent plastic screen is held in place by a cardboard frame that fits over the face of the display. Two small tabs on the console prevent the overlay from sliding out. Any attempt to work the games without the overlays proves at once that a little splash of color adds a great deal of enjoyment to the play.

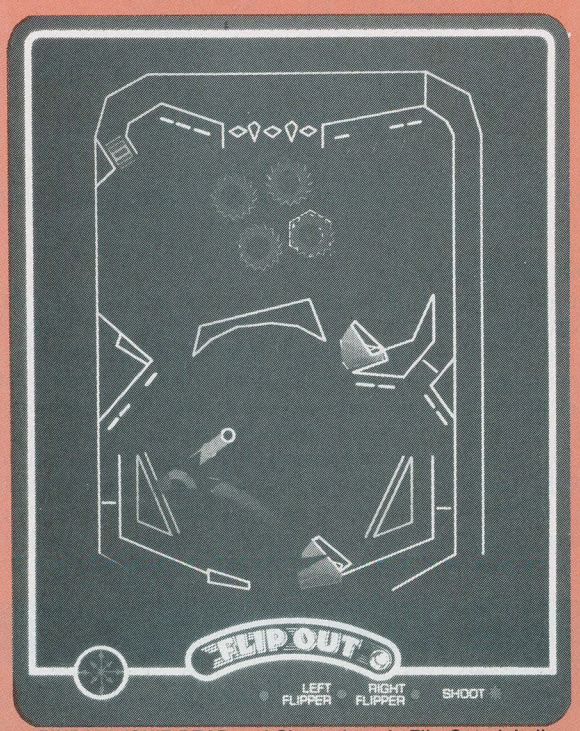
Using the *Vectrex* in an area with strong overhead light can be disturbing, though, because the light is reflected by the screen behind the overlay (there is a small gap), diminishing the visual impact of the video images gliding along just below the surface of the overlay.

Controllers

If you press a small tab under the display, a hinged controller-box drops down; it can be moved to any comfortable playing position. On the control panel are four pushbuttons and a joystick. For each game, any combination of controls may be called



VETREX'S GRAPHICS capabilities are shown in *Web Warp*.



PINBALL ISN'T DEAD yet! Shown here is Flip Out pinball.

into action. As a reminder to the game player, the function of each button is summarized at the bottom-right of every game overlay. The buttons don't have the same degree of travel as those in arcade games, but the feel of complete control and the capability for manual rapid-fire is there. The joystick, however, is too short and has too much travel for some games. Perhaps as more *Vectrex* units are sold, someone will market an upgraded controller panel. It will be easy enough to install because the standard panel plugs into the console. A second controller jack is also provided but, so far, two-player games have the opponents taking turns, instead of participating in head-to-head (or hand-to-hand) competition.

In a recessed cavity behind the control panel is a RESET button, the ON/OFF-VOLUME control, and a small speaker. The audio amplifier within the unit can produce enough sound for even the noisiest playing environments. Sound quality could be enhanced, however, if it were possible to hook up an external amplifier and larger speaker. Game cartridges plug into a slot on the lower-right side of the cabinet; if no cartridge is inserted, the unit automatically starts with its built-in game.

Cartridges

GCE's initial library of cartridges includes some excellent-looking, -sounding, and -playing, games. Several are in the Asteroids vein, with a central rotating spaceship shooting at debris floating by. One of the favorites, however, is *Scramble*, based on the arcade game of the same name. A jet fighter must maneuver through several levels of horizontally scrolling scenes. Various ground-based missiles and airborne enemies are out to blow away your fighter. At the same time, your fuel gets used up, requiring you to bomb fuel tanks along the way if you're going to have enough gas to destroy the enemy fortress in Level Six.

New for 1983 are six cartridges, bringing the total to 18. Most notable of the new batch are *Web Warp, Flip Out Pinball*, and *Spike*.

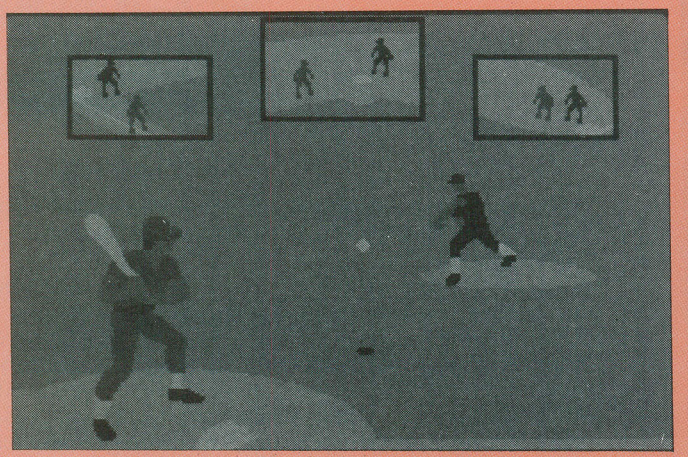
Web Warp is a two-screen adventure, starting you out piloting a space jet in a webbed, U-shaped trench receding to infinity. As you maneuver up and down the sides of the trench, the monitor's perspective of the web changes slowly. The net effect will give some players vertigo—that's how well graphics can be executed on the *Vectrex*.

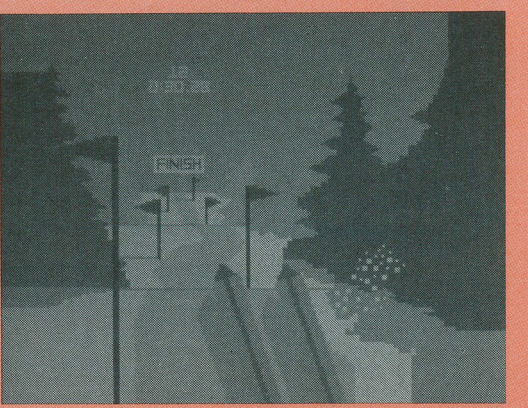
The pinball game is the first home-video version to provide a proper, vertically oriented, playfield. Flipper action is one of the best in home games, but still not up to the real thing. Ball movement, however, will rival that of any other home pinball-game. One thing no videogame has yet done successfully, though, is to find a way to communicate to the video screen the effects of body-English on a pinball box.

In *Spike*, the first talking videogame cartridge that doesn't need a synthesizer box, the skill required to help Spike rescue Molly makes up for the frivolous use of speech synthesis. In the first screen, for example, you must make Spike hopscotch from tile to tile before the one on which he is standing dissolves or scrolls off the top of the screen. A successful trip to the end of that challenge reveals a doorway off to one side through which Spike must leap—only to encounter a different challenge of hand-eye coordination.

The *Vectrex* games are complex. For the most part, they are designed to keep even the "hot shot" arcader engrossed or challenged. At that GCE is very successful. Most of the games start out tough, and get more difficult from there. That's good news for home gamers who don't find Atari-type games challenging enough. Just remember, though, that until a broader range of cartridges appears, the *Vectrex* is more for the serious videogame player than for the novice. **R-E**

SOFTWARE & ADD-ON'S FOR '83





There are some innovative and exciting games scheduled for release this year. Here's a look at just a few of them.

DANNY GOODMAN

A VIDEOGAME EXECUTIVE, EARLIER THIS YEAR, LIKENED THE Atari *2600* to a Chevrolet, in that it is something of a mass-market standard and should enjoy a degree of longevity, even in competition with Maserattis and Rolls Royces. There are so many *2600* consoles installed in homes—10 million by some estimates—that an attractive market exists for new cartridges, new controllers and other add-ons just to expand the use of those existing videogames. And just as Chevrolet has a runner-up, Ford, to contend with, so Atari watches the second-best-seller, Mattel's *Intellivision*, get the benefits of providing a lucrative aftermarket as well.

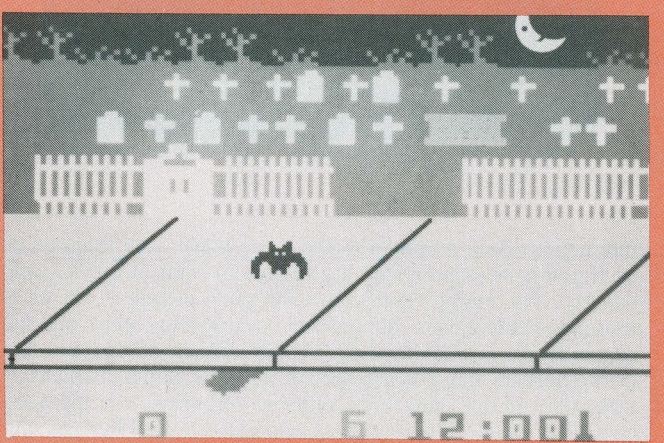
With so many engineers in dozens of companies poking around *2600* and *Intellivision* consoles, it's not surprising to see novel applications and software still coming around. Last year we saw Starpath's *Supercharger* soup up *2600* graphics resolution. (See the separate article on the Supercharger elsewhere in this special section.)

In 1983, CBS Video Games (41 Madison Avenue, New York, NY 10010) is introducing a series of games that perform graphics enhancement within the cartridge itself. A special integrated circuit, developed exclusively for CBS, adds RAM capacity to the *2600* from inside the cartridge. One of the first two games to use the *RAM-Plus* IC is *Wings*, an aircraft simulator that displays several instrument-panel readings, and the horizon line through the windshield. Another enhanced game, *Tunnel Runner*, attempts a three-dimensional perspective of walking down corridors in a maze. From a prototype we saw, however, the effect, though good, was not up to the illusion accomplished in Starpath's *Escape from the Mindmaster* game for the *Supercharger*.

Spectra Video, Inc. is at work on three-dimensional games for which players must wear red-blue glasses like the ones they hand out at 3-D movies. The spatial effect in *Vortex* is of a three-dimensional field of meteors, through which you must maneuver a spaceship.

2600 computers

Emerson (One Emerson Lane, Secaucus, NJ 07094), Spectra Video (39 W. 37th St., New York, NY 10018), and Entex (303 W. Artesia Blvd., Compton, CA 90220) have introduced computer keyboard add-ons for the *2600*. The Entex version has a number of impressive features for a simple videogame supplement. Central to the Entex *2000 Piggyback Computer* (about $130) is a Z80A microprocessor, 8K of ROM with a limited BASIC language instruction set, and 3K of RAM, which is expandable to 18K with an optional memory-expansion cartridge. A standard, full-travel keyboard includes nine function keys, four cursor-movement keys, and several other important



YOU'RE DRACULA and you're thirsty in Imagic's *Dracula*.

SOME GAMES CAN be played much easier with a roller controller. Shown here is Atari's *Trak-Ball* for the *2600*.

functions not found on other low-end computers. Software cartridges will focus on home management, self-help and elementary education. An optional cartridge will allow programs to be saved or loaded on cassette, and RS-232 communications capability is planned.

Atari will also have its own *2600* computer keyboard later this year. Probably called *My First Computer*, the add-on will offer enhanced graphics with a new series of cassette tape-based software.

One of the more practical devices to appear on the scene this year is the *Videoplexer*, by Compro Electronics (365B Clinton St., Costa Mesa, CA). For about $60, you get a box capable of holding up to eight cartridges. At the press of a button, the *Videoplexer* selects one of the cartridges for play. That will save wear and tear on both cartridges and console slot, if you like to switch among several cartridges during a play session. Models are available for the *2600* and *Intellivision*. The toughest part, though, may be selecting only eight cartridges from your library to store in the *Videoplexer*.

Controllers

New joysticks and controllers abound, especially for the *2600*. Questar (670 NW Pennsylvania Ave., Chehalis, WA 98532) offers a small rapid-fire box that goes in-line between any joystick and the *2600* console. The firing speed is adjustable with a knob on the box. The same company makes heavy-duty controller consoles that replicate the feel of arcade control-panels with joysticks and FIRE pushbuttons (one each for left- and right-handed players). A version with two fire buttons (for lefties and righties) is now available for Colecovision.

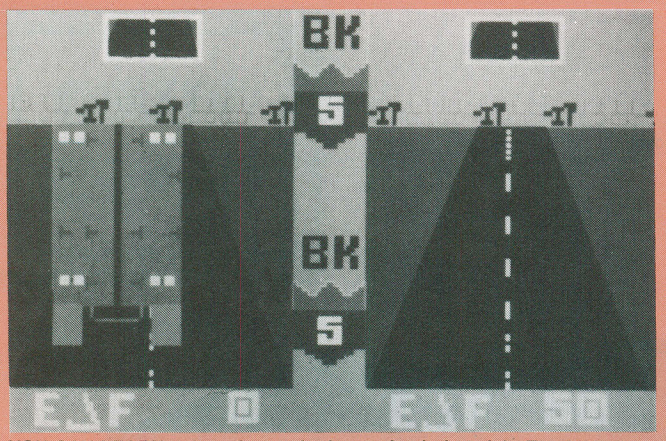
Amiga (3350 Scott Blvd., Santa Clara, CA 95051), a new company in the game business, has demonstrated a *Joy Board* controller—a combination joystick and skateboard. You use the device standing up, controlling the eight-contact switch by throwing your weight in the appropriate direction. One application is with Amiga's skiing cartridge, in which you have a skier's eye view of the slopes as you try to maneuver through the gates.

Atari has finally emerged with a few new control packages for the *2600*. A track-ball controller should be available soon, as will a *Proline* joystick with a hand-contoured grip and faster response than the standard units. A new wireless joystick set will finally let Atari partially fulfil one of its dreams—a wireless all-in-one-controller console—that never made it to market.

For less experienced *2600* players, a new *Kid's Controller* will be usable with Atari's latest educational software endeavor with the Children's Computer Workshop (part of the Children's Television Workshop). Apparently, little hands have difficulty managing joysticks. Atari's answer is a 5 × 7-inch, 12-button, keyboard that uses overlays from each cartridge activity to let the kids move characters more easily or enter keyboard input. In one game, for example, four "arrow" buttons are used for direction and another button is pressed in place of a FIRE button.

Atari cartridges

The first five titles in the series for 3-to-7-year-olds are

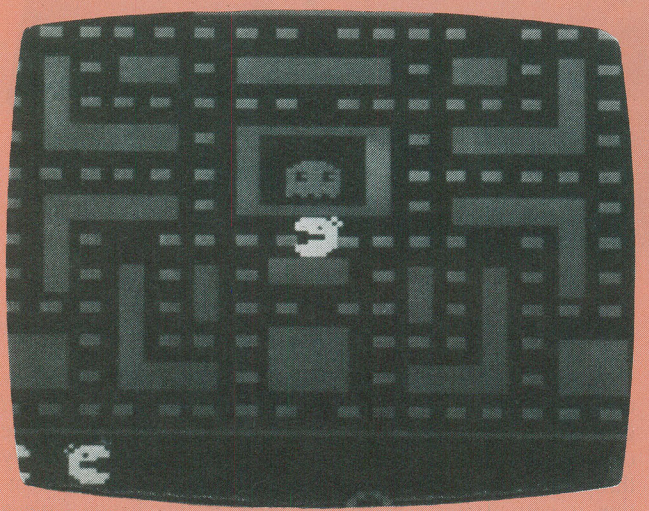


YOU CAN LEARN some of a trucker's worries in Imagic's *Truckin'*.

(tentatively), *Oscar's Trash Race, Cookie Monster Munch, Big Bird's Egg Catch, Grover's Music Maker*, and *Alpha Beam*. Later this year, the Atari *Kid's Library* will have new characters join the learning experience—including the Peanuts gang, and Walt Disney favorites Mickey Mouse, Donald Duck and others.

Most of Atari's other introductions for the *2600* are from arcade titles. *Centipede, Ms. Pac-Man* (which does more justice to the arcade original than Atari's *Pac-Man* does), *Vanguard* and *Dig Dug* will probably be the most popular.

While most other software companies pursue arcade titles and



MS. PAC-MAN does a creditable job of adapting the arcade original.

other popular-culture tie-ins (movie hits, TV shows, etc.) some of the best work is coming from the small group of successful, fresh game companies like Activision (2350 Bayshore Frontage Road, Mountain View, CA 94043) and Imagic (20665 Fourth Street, Saratoga, CA 95070). The best games of 1983 are more likely than not to come from one of these two companies.

Among contenders for the top *2600* cartridge crown will be Activision's *Enduro*, a challenging car-race game, complete with the most convincing fog sequence on home video. *Robotank* will be a favorite among hard-line gamers, as they steer a remote-control tank (the TV screen is looking through the tank's video camera) to meet the enemy under all kinds of environmental conditions. Even those two, however, will have a tough time beating out *River Raid* for its unending challenge. In that vertically scrolling game, you're never quite sure how tricky the next series of waterways will be (you must steer your bomber only over water), nor how far it will be to the next fuel tank to get more gas.

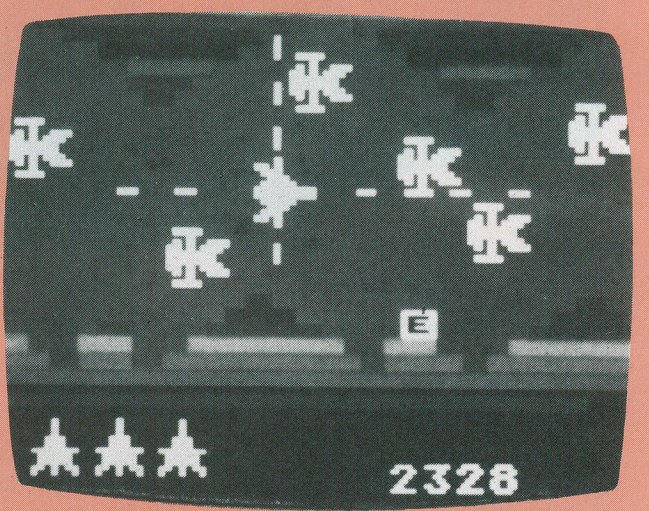
Parker Bros. (50 Dunham Rd., Beverly, MA 01915) seems to be about the only software company to consistently take a pop-culture theme and create an interesting, good-looking game around it. Two more cartridges in its Star Wars series are planned for later this year, as they also tackle some of the most graphically challenging arcade conversions.

New for Intellivision

The Imagic team has been busy working on *Intellivision*-compatible cartridges, and will likely take *Intellivision*-cartridge honors in 1983. *Ice Trek* is a nerve jangling challenge to build an ice bridge across open water. With a rope and hook, you must catch chunks of ice as they float by and join them to the bridge you're already built. The catch is, however, that ice flowing in the water can also knock away pieces of the bridge you've made.

A more strategic activity is *Truckin'*, best as a two-player game. The rules are complex in this simulation of a trucking business. You make decisions about which loads you want to carry to specific destinations. You then follow true-to-life roadmaps, as you drive down the road (viewed out of the truck cab), through open country, into cities, etc., to drop your load and collect payment. Money goes out, too, for gas, speeding tickets, repairs (if you're in a wreck) and so on. If you drive too long without resting, your top speed drops as you fall asleep. You may encounter a mad trucker who tries to run you off the road. There is so much going on, both on-screen and off, that you forget you're playing a simple home videogame.

Imagic, by the way, has also demonstrated that the *Odyssey*^{2} system is capable of interesting graphics after all. Odyssey



ANOTHER ATARI cartridge, *Vanguard* is a fast-moving "shoot-em" game.

versions of the popular *Demon Attack* and *Atlantis* bring out some of the system's finest capabilities.

One final mention of a cartridge from a company new to home games, but a respected veteran of the arcade scene: Sega-Gremlin Industries (16250 Technology Dr., San Diego, CA 92127). One of its new Atari *2600* cartridges should prove to be a favorite among the dyed-in-the-wool shoot-'em-up crowd. *TracScan* is one of the fastest action space fights around. The solitaire game uses the *2600's* paddle controllers for nimble response of your multiple fighters as they twist and turn in free space. The play alternates instantly between offensive and defensive maneuvers and offers quite a challenge to those with quick hand-eye skills.

There are now so many videogame cartridges available for the *2600* and *Intellivision* that there would never be enough space here to comment on all of them. So keep tuned to **Radio-Electronics** every month, as we help you separate the great games from those that aren't, to stay on top of this fast-moving industry. **R-E**

Whenever home-videogame enthusiasts gather to play and talk about games, there's almost always an argument as to which is the best videogame around. In this article we'll try to settle those arguments, or perhaps start a few new ones, by giving our choices of the best 10 videogames to be introduced in the past 12 months.

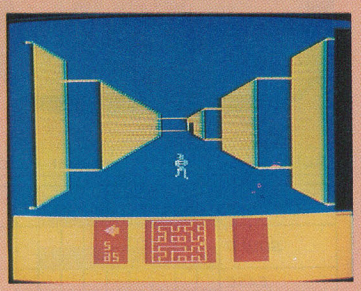
VIDEO GAMES

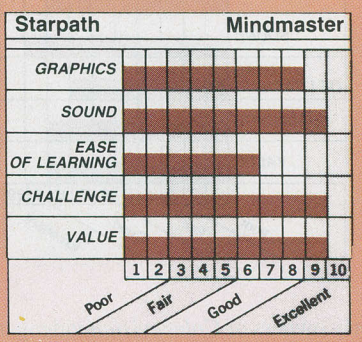
THE TOP TEN GAMES OF '83

DANNY GOODMAN

1

Starpath's Escape From The Mindmaster For Atari 2600





As many of you know by now, the *Supercharger* add-on for the Atari *2600* greatly expands the graphics and memory capability of that game system. (If you are unfamiliar with that device, it is detailed in its own article elsewhere in this section.) Developed by Starpath Corporation (324 Martin Ave., Santa Clara, CA 95050), the *Supercharger* uses specially designed tape cassettes rather than the usual cartridges. There are several advantages to that scheme. For one, cassette tapes are much cheaper to produce than cartridges, which allows the games to be sold at relatively low prices. More important, however: Some cassettes, like *Escape From The Mindmaster*, use multiple loads. What that means is that the games can be made far more complex, with each load presenting new screens and challenges.

Escape From The Mindmaster makes good use of the *Supercharger's* enhanced graphics, providing you with a view down corridors in a maze that rivals anything we've seen, even in computer games. There are four cassette loads in all. Within three of those loads are six completely different mazes. The fourth and final cassette load reveals your final score, plus a rating assigned to you by the "Mindmaster." Each maze challenges you to find four distinctly shaped "pegs" and their respective holes. Each peg has to be carried, one at a time, to its proper hole. When that task is completed, you have to find the secret door to move to the next, more challenging maze.

One reason that the mazes get more difficult is that as you move up, the pegs become more difficult to distinguish from each other. Also, the mazes themselves get more complex. And then there is the problem of an alien stalker roaming the maze; he's out to eliminate you. You do have the advantage, however, of sound clues that give you a little forewarning when he's sneaking up on you or when he's just on the other side of a doorway.

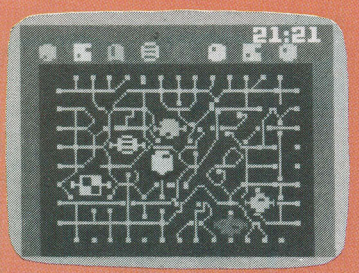
There are other obstacles you must overcome. For instance, in mazes two and up, dangerous force fields zap across some of the corridors you need to travel. Also, in the first five mazes, you will run into tests of coordination, memory,

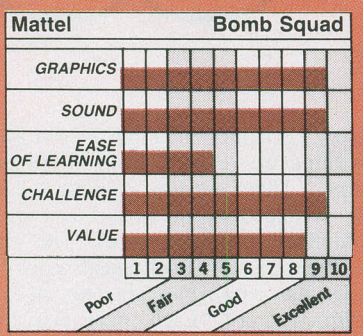
reflexes, agility, and dexterity. In the meantime, you'll probably forget where you saw that missing peg. There is a radar screen, however, that helps you see the entire maze from above, and where you are in it.

Escape From The Mindmaster is not a casual game, one that you can play around with for a few minutes. A session can last twenty minutes, or more if you're really good at it. The challenge for even very experienced game players will be much greater than it seems at first. And even though you start out with nine chances to beat the "Mindmaster," it will be many dozens of hours of play before even the best players can escape.

2

Mattel's Bomb Squad For Intellivision





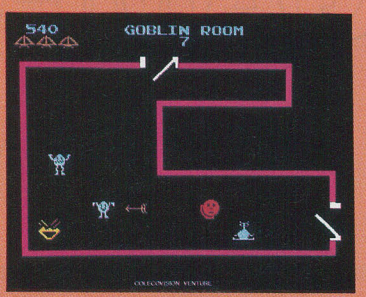
OF ALL THE EARLY CARTRIDGES introduced for mattel's (5150 Rosecrans Ave., Hawthorne, CA 90250) *Intellivoice* speech synthesis module, *Bomb Squad* is the one you're most likely to play again and again. Multiple display screens, a well-integrated electronic voice, and enough levels of difficulty to keep players challenged practically forever, make this game a worthy addition to the *Intellivision* library.

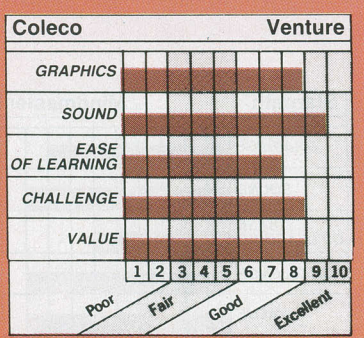
In this game, you become a bomb-disposal expert (that is, if you become good at it) racing against the clock to disarm a massive bomb set to destroy the city within about twenty minutes. Your overall goal is to deduce the secret code number(s) hidden behind a grid of twenty squares. Each square represents an electronic circuit, which must be repaired to reveal part of the secret number. With three tools (wire cutters, pliers, and a soldering iron), you follow instructions given to you via the voice module by your electronic associate, "Frank." Some components need to be replaced by jumpers, others by similarly shaped or colored parts from a kind of parts box on screen. Cutting out a piece in the wrong order starts the countdown timer going even faster, and Frank tells you if it's the wrong part.

As with many Mattel games, this one is not easy to get the hang of at first and a thorough reading of the manual is in order. But once you get the idea, you'll be hooked. If, in the course of a game, you run out of time or guess wrong: Frank gasps, "Oh no!" and the city skyline loses about one-third its buildings in the blast. By solving the puzzle, however, you're treated to a fireworks display and verbal plaudits.

3

Coleco Venture For Colecovision





Early owners of *Colecovision* videogame systems by Coleco (South Quaker Lane and New Britain Ave., West Hartford, CT 06110) have had only a handful of high-resolution games to play, but most of those have proven to be very appealing. The best of the bunch, however, is *Venture*, a home videogame that has proven to be more popular than its arcade ancestor.

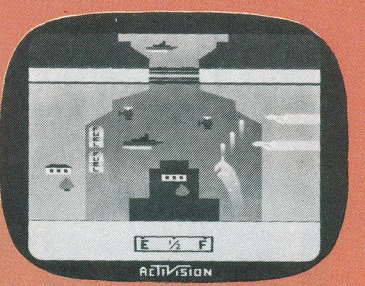
You could call *Venture* an adventure-type game, but it's not in the tradition of *Dungeons & Dragons*. Rather, your screen character, called "Winky," must retrieve treasures from a succession of rooms. Each room has two entrances from a master hallway. Hallways are guarded by deadly "Hall Monsters." Inside each room, a group of three creatures guards the treasures. Winky can shoot the creatures with his bow and arrow, or dodge them to retrieve the treasure and scram from the room without being touched. If Winky waits too long, however, a Hall Monster will come into the room and invariably catch him.

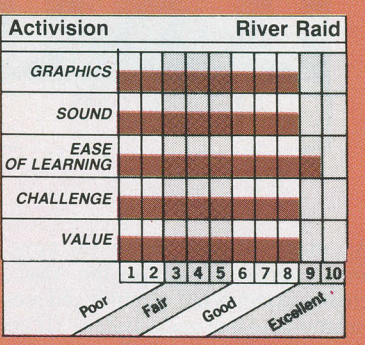
What is so interesting about *Venture* is the number of different screens and music tunes that appear during the course of the game. The first screen is a "macro" shot, with your Winky just a small dot. You maneuver him to an entrance to one of the rooms. Then the screen changes to a blow-up of that room, with its treasure and creatures. Each level has four rooms. After three levels (12 rooms), the rooms and their respective creatures repeat, but the creatures are a bit more aggressive.

Venture is a joystick-crunching good game for the hard-core player. There is plenty of challenge as you try to pick up all thirty-six treasures indicated on the scoring screen. The experienced player will, in time, "top out" and find that the last four rooms repeat. But the graphics resolution of the creatures and extremely wide variety of music makes *Venture* fun to play over and over.

4

Activision River Raid For Atari 2600





Although the prevailing attitude among game-industry observers is that women don't like to play heavy artillery shoot-'em-ups, they apparently haven't taken *River Raid* by Activision into account. That cartridge, which puts the player at the controls of nothing less

sinister than a B-1 bomber, was designed by a woman, Carol Shaw.

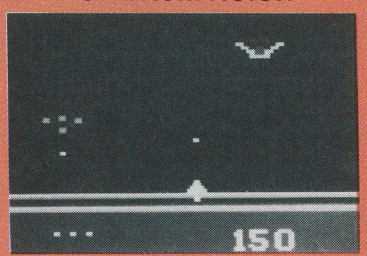
Colors on *River Raid's* vertically scrolling screen are vivid, although the graphics are not necessarily more interesting than those of many other games on the market. The view is from above a low-flying bomber on a strafing mission up a river deep in enemy territory. Targets include ships, helicopters, bridges, and fuel tanks. Fuel tanks also contain precious fuel for the jet as it penetrates deeper into the mission. You have the choice of flying over the tank to pick up gas, or blowing it to smithereens for points if you have enough fuel to get to the next tank.

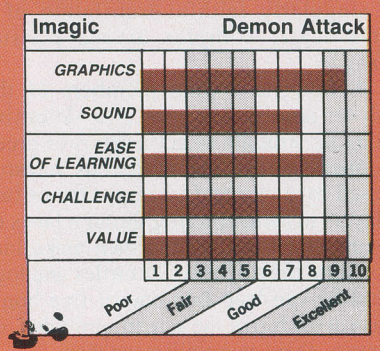
On the ground below, the river breaks off into narrow channels in places. Joystick control of the bomber lets you bank left or right (with an accurate representation of the banking maneuver by the jet), or speed up and slow down as needed to time shots or collect more fuel.

What makes *River Raid* so appealing, is that if there is a pattern to the river and all its ships or tanks, it will take a good long time to figure it out. There seems to be a wide variety of channel designs and density of enemy hazards. With the scrolling field below, you're never sure what kind of formation to expect, so you've got to look ahead, while making sure you don't run into a ship or river bank. You're also never quite sure when the next fuel tank will come—one more thing to worry about in this very enjoyable "quick-hit"-type game.

5

Imagic's Demon Attack For Intellivision





Imagic (981 University Ave., Los Gatos, CA 95030) has quickly become one of the foremost producers of third-party software for Mattel's *Intellivision* console. Instead of merely converting graphics and game play from Atari-compatible cartridges, Imagic is busy pursuing entirely different games for their *Intellivision* line. And, while some very exciting games are due from Imagic in the second half of 1983, last year they produced a version of their most popular game ever, *Demon Attack*.

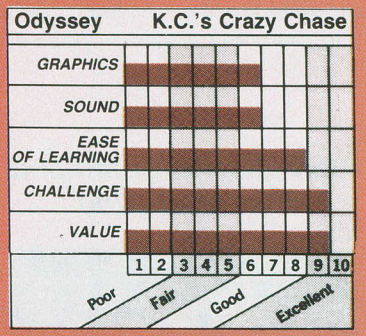
The *Intellivision* adaptation of that game is much more colorful than the ones available for the Atari *2600*, *Odyssey*^{2}, and Commodore *VIC-20* computer; it also produces two alternating screens. The action in the first screen takes place on the Moon's surface, complete with craters and a view of the Earth in the background. Your job is to fire your laser cannon at the descending, bomb-dropping demons, which at first come individually, then in pairs, and then in squadrons of six across. In multiple demon waves, the enemies split up as you start making direct hits. If you survive that part of the game you move on to the second screen, which puts your laser cannon out in space. Your mission there is to try to destroy the demons' "flagship." This ship is a beautifully crafted piece of videogame art. Suicide patrollers (bird-like creatures) impede your shots as you wait for a chance to shoot at the revolving "Window of Vulnerability." A direct hit at the right instant destroys the flagship, and you return to your moon base to take on more intense waves of demons.

Game play options allow for one-player, two-player competition (each player takes turns), or two-players working together (each player gets alternating four-second turns against the same wave of attackers). Imagic also offers an automatic firing option, which, as in Mattel's *Astrosmash*, saves the thumb from the strain caused by repeated pressing of the "fire" button.

Demon Attack is surely one of the best shoot-'em-ups for the *Intellivision* we've seen.

6

Odyssey K.C.'s Krazy Chase For Odyssey^2



Although Odyssey's (I-40 & Straw Plains Pike, Knoxville, TN 37914) overuse of mazes in so many of its games tends to make them look alike after a while, *K.C.'s Krazy Chase* is nevertheless an entertaining, non-threatening game that the entire family can enjoy; it is clearly one of the very best available for that game system. It is also one of the first cartridges to make use of the *Odyssey*^{2} voice-synthesis module.

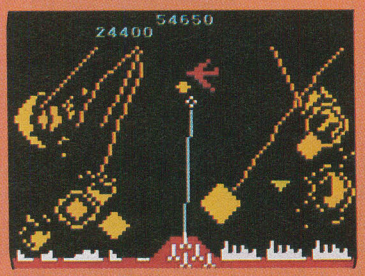
The object of the game is for your "K.C." character to munch up a multi-segmented, caterpillar-like creature called a "Dratapillar," as both maneuver through a maze. The Dratapillar has two aides, called "Drats," who are also in pursuit of K.C. Every time K.C. manages to eat a rear segment of the Dratapillar, it's open season on Drats, and K.C. can disable them temporarily, while claiming bonus points. The real danger for K.C. is the head of the Dratapillar, which is not disabled until K.C. finishes all the rear sections. At that point, a new, faster Dratapillar appears and the chase is on again.

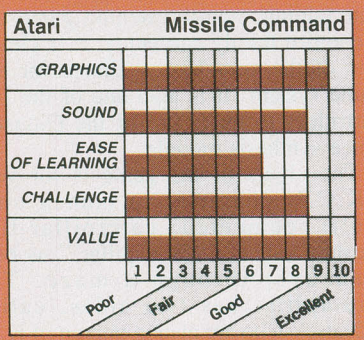
Without the voice module, the game sounds are not all that spectacular. But that is definitely not the case when the module is used. With it, for example, K.C. has something to say after completing each Dratapillar: "Incredible." He also lets out a contagious laugh that always elicits a chuckle from human players and onlookers, even after many, many times. Not all the bugs have been worked out of the voice-synthesis module, however, as occasionally the words don't match up with the action on the screen. In particular, words of warning or danger are issued, yet there is no hazard anywhere near. That detracts slightly from an otherwise thoroughly enjoyable game.

The game may sound and look simple, but it is not a snap to master. The Dratapillar takes on considerable cunning and speed at higher levels. Compared with maze games available on comparable systems, *K.C.'s Krazy Chase* ranks well above *Pac-Man* and *Night Stalker* in that all-important element of good game play: playability. It

appears to be extremely popular with young and old alike, and that's the best way to gauge any game's worth.

Atari Missile Command For Atari 5200





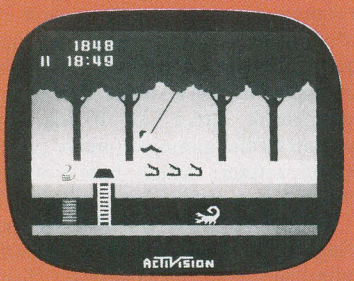
Very few videogames have maintained their popularity for as long as *Missile Command*. Originally made famous by Atari's arcade game, the version developed for play on the Atari *2600* home system is generally thought to be one of the industry's best early arcade translations. Now Atari has introduced an even better version for their high resolution *5200* game system, one that offers exciting graphics and true-to-arcade action.

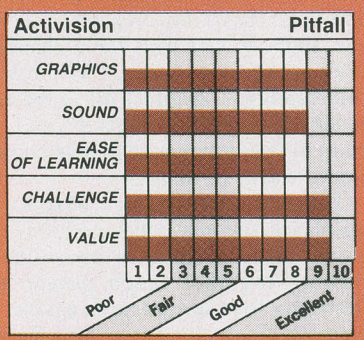
In *Missile Command*, the player guards six cities with a missile launcher located at the bottom of the screen. Coming in from overhead (out of the sky, from satellites, and from low-flying aircraft) are ballistic missiles that leave trails as they fall. You don't actually shoot at those missiles, however. Instead, you have to detonate an anti-ballistic missile in mid-air in the path of an oncoming missile; that's done by directing your cursor to the assigned spot and pressing the "fire" button. If you are successful, your anti-ballistic missile sets off an explosion that engulfs the enemy missile. Those you miss come to just above the planet's surface and, like any nuclear bomb, let off an explosion that can wipe out the nearest city.

Of course, as the game progresses, the waves of enemy missiles increase in speed and intensity. At best, you try to fill the sky with your own missiles' blasts, but your resources are limited.

The display on the *5200* version is very crisp and colorful, as you might expect. If you have seen the arcade version, you'll marvel at the close resemblance. Perhaps the only difficulty you'll have with *Missile Command* is controlling the cursor accurately with the hand controllers non-self-centering joystick. But when used with the optional Trak Ball (the arcade version was one of the first to use that type of controller), you'll barely be able to tell you're not popping quarters for the privilege of playing.

Activision Pitfall For Atari 2600





If *Pitfall* by Activision (Drawer 7286, Mountain View, CA 94042) is the best-selling videogame cartridge of all time, it is deservedly so. It is one of the few long-session, adventure-type games that attracts players who otherwise prefer quick-hit, arcade-style activities.

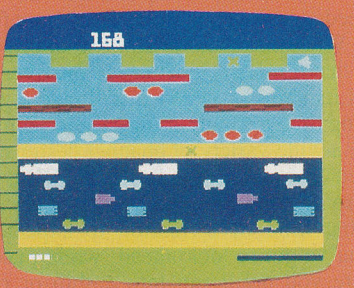
The goal is simple: Within twenty minutes, maneuver your screen character, "Pitfall Harry," over and through numerous hazards in search of dozens of treasures scattered about in the jungle. Mastering the hazards takes considerable practice, as it requires fairly precise timing to deal with the quicksand openings, swinging vines, and alligator mouths ready to eat Harry.

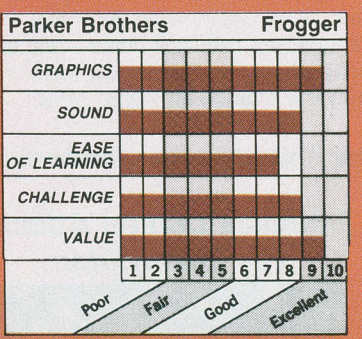
The charm of *Pitfall* is that there are so many avenues to explore and so many hazards to master that you can keep playing it for weeks and never exhaust its possibilities. Sure, the hazards repeat themselves after a good long time, but the opportunities for scoring more points and discovering new shortcuts don't diminish, no matter how good you get.

The game is graphically appealing, giving Harry much detail, and keeping the background, foreground, and hazards also interesting throughout. Sound doesn't play much of a role in the game, but the simulated Tarzan call as Harry swings on a vine is just the right kind of icing on this prize cake. This is one cartridge that should be on your "must have" list of *2600*-compatible cartridges.

Pitfall is also available for *Intellivision*. Although that version doesn't make full use of the console's graphics capabilities, the game play is definitely worth adding to an *Intellivision* library.

Parker Brothers Frogger For Atari 2600





While the limitations of the Atari *2600* console usually makes the exact duplication of arcade graphics and sound impossible, Parker Brothers (50 Dunham Rd., Beverly, MA 01915) has introduced a singularly faithful translation of a graphically complex arcade classic, *Frogger*.

A favorite among members of the whole family, *Frogger* is a defensive dodging struggle to get a series of green hoppers across the numerous hazards posed by a city and swamp. One or two players maneuver a frog through lanes of racing street traffic, and then make him hop onto moving rows of turtles and logs until he can leap into one of five home bays at the top of the screen, provided, of course, there is no alligator there.

The game contains several fine points that the designers successfully integrated into the home cartridge. For example, on

continued on page 108

VIDEO GAMES

VIDEOGAMES THAT TALK

The words that ushered in talking pictures are now heard again on the videogame front... "You ain't heard ***nothin'*** *yet!"*

DANNY GOODMAN

WHEN EVALUATING VIDEOGAME SYSTEMS AND CARTRIDGES, home gamers place first emphasis on graphics, the most readily apparent quality in the predominantly visual medium of television. Not enough attention is paid to sound quality or its effect on game play. Unfortunately, it seems that the designers of many cartridges pay equally little attention to the importance of sound. They borrow from a familiar library of sounds already employed in earlier generations of cartridges, and in many cases add sound elements as pure ornament.

The advent of low-cost solid-state speech synthesizers holds the promise of a greater use of sound as an interactive part of game playing. Instead of hand-eye coordination dominating the game play, clues can be "spoken" to the player, thus bringing into play the hand-*ear* connection. And since the hands, eyes, and ears are all controlled by the brain, there is an opportunity for well designed home-videogame cartridges to more fully exercise the mind's ability to react to multiple stimuli.

But, judging from early attempts by the few home-game makers to dabble in voice synthesis, a lot more work remains to be done in applying the technology meaningfully to game playing. GCE's *Vectrex*, *Odyssey*^{2}, and Mattel's *Intellivision* all offer voice games having varying degrees of quality and gameplay integration.

Voice-synthesis basics

Intellivision and *Odyssey*^{2} use add-on modules to produce what are among the most natural sounding electronic voices available at consumer-product prices. Speech from the *Vectrex* system, on the other hand, is created by carefully programming the sound-generation circuitry already incorporated within the unit.

The two add-on modules contain a speech-synthesis IC-set manufactured by General Instrument. Instead of the "robot-like" speech created by linking synthesized phonemes (the basic sounds from which words are formed) together (Votrax offers such a synthesizer for a number of personal computers), the GI IC's generate speech according to a method known as linear-predictive coding, or LPC. To put it simply, LPC takes information stored in ROM (*R*ead *O*nly *M*emory) and produces speech according to a set of pronunciation rules programmed into the GI IC's. The more ROM available to the GI synthesizer, the larger its resident vocabulary.

The information stored in the ROM is actually a highly compressed digital recording of a real voice. Human speakers—male or female, in any language or accent—can record sounds that are later "reconstituted" by the GI IC's. Real sound-effects can be similarly recorded.

COLECO ADDS VOICE to the Atari *2600* with the *Gemini* madule that uses special cartridges & tapes.

Although both *Intellivision* and *Odyssey²* use the same speech-synthesis method, that is where the similarity between the two ends. Each has taken a vastly different approach to marketing its voice technology, to designing its voice game-cartridges, and to the degree of interaction between voice and game play.

Voice of the *Odyssey²*

Odyssey²'s voice module—designed to match the game console in appearance—fits over the top of the console without hindering access to the flat membrane keyboard. All power for the module comes from the original cartridge slot, and a new slot for cartridges is located on the module. A sliding volume control is located beneath its speaker.

The voice-module circuitry contains a vocabulary of more than 100 words spoken by a male voice, plus many "pre-recorded" sound effects, and musical tones covering a two-octave range. Also stored is a complete set of allophones (speech sounds) that can be linked together in any order to produce any word, although in a very artificial-sounding fashion.

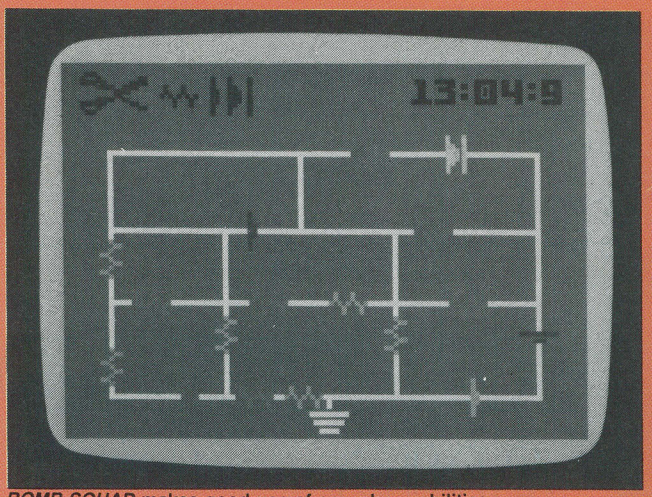
The words and allophones can be called up by a properly coded game cartridge. The cartridge does not need to contain the digitized voice data, but, rather, instructions that will cause the voice module to utter its words. The game cartridges, therefore, can be used either with or without the voice module. Game play is only "enhanced" (Odyssey's word) by the voice. In other words, you can fully enjoy a game like *K.C.'s Krazy Chase* or *Smithereens* without the voice module. With the speech module, a voice is heard in the background; its purpose is to heighten excitement, and to add humor in spots. While that approach makes any voice-enhanced cartridge compatible with non-vocal systems, it also means that speech must not be so integrated into the game as to be essential for game play.

An odd thing happens when playing voice-enhanced *Odyssey²* games. During a game, the words coming from the module don't seem to correspond very closely to the action on the screen. *K.C.'s Krazy Chase* is the most disturbing example. In that game, you control a munching creature (K.C.) who must devour each aft section of a multi-segmented caterpillar-like character (the Dratapillar) as it wends its way through a maze. Two other characters, called Drats, float about the maze. K.C. mustn't be touched by drats or the Dratapillar's head, or the game is over. The voice, presumably that of some supreme videogame being, urges you to "hurry," "look out," "run," etc. Even if K.C. is a long way from the nearest hazard, the voice is likely to tell you K.C. is in danger.

Only at the end of each round, when K.C. lets out a high-pitched laugh and says, "Incredible," while his lips move and his eyes wink, does the voice help that cartridge.

As *Odyssey²* game designers continue to work with the capabilities of speech synthesis, they seem to be making the words correspond more closely to the action on the screen. In the two-player game *Smithereens*, the voice module reproduces the digitized sounds of explosions and the whistle of boulders screeching out of the sky. And in *P.T. Barnum's Acrobats* (a version of *Circus Atari*), the voice output coincides with your scoring a string of points ("Grrreat!" and "Good"), or is heard when you fail to place the teeter-totter under the falling clown (a mixture of "Oh!," "Aargh!," "Squash!," "Ouch!" etc.). Still, the words are only an ornament for an otherwise playable game.

An educational cartridge, however, brings along its own vocabulary. *Sid the Spellbinder* adds 99 new words to the *Odyssey²* in a children's activity that is half arcade-game, half spelling bee. Starting out with 20 missiles, the student must shoot away segments of Sid, a large centipede-like creature, as he snakes across the screen. The player earns points for each section hit. If he misses any by the time Sid reaches the bottom



***BOMB SQUAD* makes good use of speech capabilities.**

VIDEO GAMES

of the screen, Sid eats up some of the reserve missiles. Next comes a spelling bee, in which the voice asks for the spelling of three words from the cartridge vocabulary. Proper spelling (input by pressing the keys on the keyboard of the *Odyssey*^{2} console) earns more ammo for future rounds with Sid.

Some words, like "said" and "than," are not easily intelligible, even using the high quality LPC system. And, oddly enough, the cartridge quite frequently combines a prerecorded LPC voice with the cruder allophone-type speech within the same sentence. Perhaps children won't be as critical of the unevenness of voice quality as adults may be.

Educational cartridges, in which speech plays a crucial role, can be used only with the voice module. And, should the *Odyssey*^{2} game designers wish to experiment with games that need speech synthesis to be effective, the capabilities are there for that, too.

Intellivoice

The folks at Intellivision seem to believe that synthetic speech from their *Intellivoice* module should be a completely integrated game element. Voice games can be played only through the *Intellivoice*, and, unlike the Odyssey system, the voices come through the TV speaker together with the rest of the sound effects. The first few cartridges demonstrate the basic application of speech as a device to alert the player to action taking place off-screen.

The complexity of most Intellivision games in general makes speech a welcome addition. The best-selling voice cartridge, *B-17 Bomber*, gives the pilot/player no fewer than seven different screen displays to choose from: a situation map of Europe, aircraft controls, four horizontal views from the plane, and the view through the bombsight. While you're busy watching for fighters at 12 o'clock (ahead of you) a voice may warn of bandits at 9 o'clock. While you're trying to shoot an enemy plane down at 9 o'clock, your southern-accented bombardier alerts you, "Target in sight," which gives you only a couple seconds to change screens (via keyboard controllers), get your bombsight on target, and press the button. The bombardier shouts, "Bombs away!" and then a John Wayne-sounding voice urges you to, "Watch out for flack." The voices are triggered only in response to specific actions or warnings.

In "Bomb Squad," another long and involved game for the *Intellivoice*, speech plays the critical role of supplying you with instructions to replace time-bomb circuit-components with others. While you're busy with the wire cutters, grippers, and soldering iron on screen, the voice (your partner) guides you in the proper component sequence or tells what you're doing wrong. There's room for some humor as well. While you're feverishly working against the ticking clock to disarm the city-destroying bomb, the terrorist's voice taunts periodically saying, "It won't be easy." A different type of voice module is being offered by Coleco for the *2600* and their own *Gemini* system. Instead of synthesizing sounds and voices, the *Gemini Sound I* uses game-driven cassette tapes. The games available now suggest that it will be primarily for younger game-players.

That it takes great care to develop a fully integrated voice game can be deduced from the as yet small library of *Intellivoice* cartridges. The fifth and latest game, tentatively titled *Space Shuttle*, puts you on board one of those magnificent delta-winged birds from countdown, through the deployment of payloads, to touchdown on Earth. So far, no other Intellivision cartridge manufacturer has joined the *Intellivoice* movement; perhaps the feeling is that even more should be done with speech synthesis to make it a valuable element for games.

No modules

The newest method of making games talk, demonstrated in the cartridge, *Spike*, for the GCE *Vectrex* system, uses no external speech-synthesizer. Instead, the cartridge designers have found a way of making the regular game sound-system produce sounds like those of human speech. The complexity of speech is no small challenge to overcome, especially within the limitation of sound IC's best suited for musical notes, explosions and other noises.

The voice quality is far from that provided by linear predictive coding. As Spike's girlfriend, Molly, is grabbed by a bad guy, she yells, "Help Spike!" Her high voice sounds raspy (more like she's gargling than talking), and artificial, as if in a cartoon. To make sure the player understands the words properly, a cartoon-like balloon emanates from her mouth, with the spoken words showing up on the screen.

Purely software-driven speech synthesis, like that used by the *Vectrex*, may also be available soon for the Atari *2600*. Spectra Video, Inc. a relative newcomer to the videogame and computer hardware/software market, recently demonstrated a program for the Atari computer that spoke a few ornamental words in the course of the game. A versatile sound circuit, as offered with the Atari computer, makes it easier to accomplish that, but the implementation is the result of some clever programming. The company claims it will be able to work similar wonders on the *2600*. Perhaps an equally brilliant Intellivision designer will have the wherewithal to make the "Yer Out!" announcements in *Major League Baseball* sound more like an umpire really calling the play than just blowing his nose.

The most exciting feature about voice synthesis is that its use in home videogames has barely begun. As game designers learn from each other and launch new ideas of their own, we can look forward to a better understanding of how speech can be integrated with videogame playing, and to seeing games that really stimulate more of the senses and mind. **R-E**

HANDHELD AND TABLETOP GAMES

Not all the electronic-game action is taking place on TV screens.

DANNY GOODMAN

WHILE HOME VIDEOGAMES HAVE BEEN GETTING ALL THE MEDIA attention, games of the non-video sort have not been idle. There continue to be new units hitting store shelves in the handheld and tabletop categories, including the more sophisticated strategy-games like chess. This year, even handhelds are getting into the cartridge act, including the first-ever programmable pocket LCD game.

We have seen plenty of tiny LCD games (many with built-in digital clocks) over the past two years, and 1983 will be no different. Almost all those games have what appears at first to be a multi-colored LCD display. But, on closer inspection, you'll find that the colors are overlays on the display window, and the moving figures are in the traditional black against the LCD's light gray background.

Nintendo, a company best known for its arcade games like *Donkey Kong*, now offers twelve different *Game & Watch* models. Four of them even feature two different LCD screens, one on each side of their folding cases. In *Donkey Kong*, *Green House*, and *Mickey & Donald* (of Disney fame), a vertically oriented scene, like the "girders" screen in *Donkey Kong*, is split into two horizontal half-scenes. The balance of Nitendo's line are called wide-screen games, and feature some familiar characters: Donkey Kong Junior, Snoopy (playing tennis), Popeye, and Mickey Mouse.

From F. Hattori & Co., Ltd., a well known Japanese manufacturer of electronic timepieces comes in a new lineup of pocket LCD games—*Pop Games*—with more-advanced time functions than most other similar games. All thirteen units have an alarm as part of the timekeeping functions, while a few also have stopwatches. Three models also include AM radios (audible through an earphone), yet the units easily fit into a shirt pocket. Prices range from $24.95 up to $39.95 for the radio games.

A potential source of annoyance with games like these is the beeps and other noises they generate whenever an action button is pressed or a big score is made. With the *Pop Games*, and another set of games from Thumb Power, however, you can disable the tones if you'd rather play quietly.

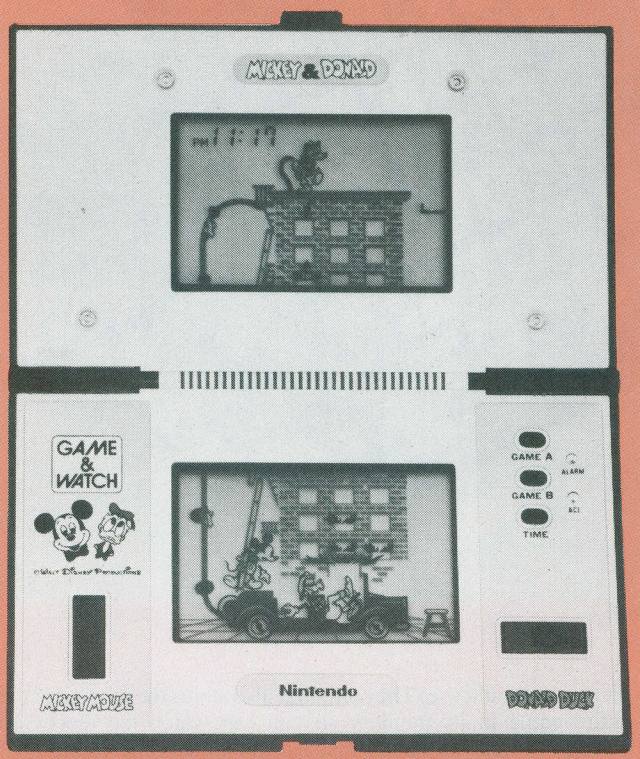
Pocket adventures

For 1983, Mattel Electronics is adding two new games to its varied and quality line of inexpensive handhelds. Likely to be a favorite is *Master of the Universe*, a maze-adventure-type game similar in concept to the LCD *Pocket Dungeons & Dragons* game introduced last year. Instead of being hand-eye reaction games (as most thumb-type games tend to be), *Dungeons & Dragons* and *Masters* are tests of memory and exercises in strategy as you move the central character through a grid. You see only one intersection at a time (its coordinates, such as "A6," denoted on the screen). Aural and visual clues alert you to dangers in nearby quadrants, as you plot your attack.

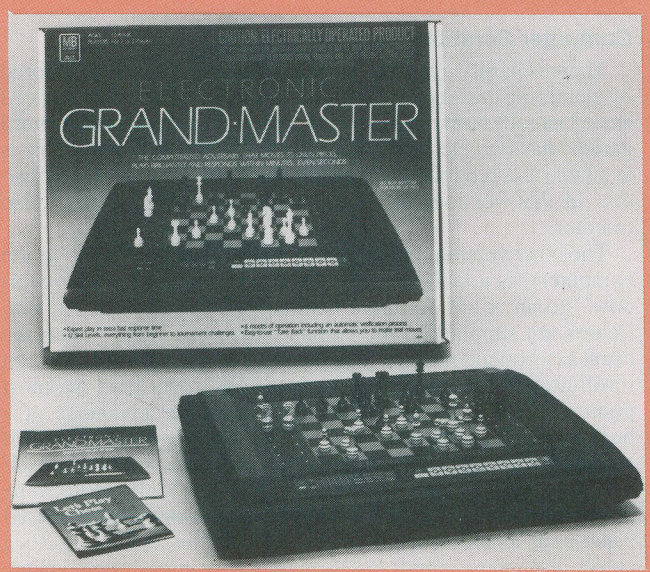
Programmability is second nature to home videogames, and is not unknown to tabletop games. But Palmtex takes the prize for the first LCD pocket game to offer plug-in cartridges. The *Command Console* ($29.95 with one cartridge) is a hinged case (like a cosmetic compact case) measuring 4.5 × 2.8 × 0.8 inches when closed. Each cartridge ($19.95) has its own multi-colored display screen to customize the graphics for the game. Twelve cartridges are planned for release by the end of 1983.

Bandai America has developed a very sophisticated dual-panel LCD handheld game that recreates a nine-hole golf game.

VIDEO GAMES



NINTENDO'S *Mickey and Donald* offers two separate LCD screens in its folding case.



THIS ELECTRONIC CHESS game from Milton Bradley moves its own pieces.

ANOTHER HANDHELD game from Nintendo—*Donkey Kong Jr.*

The top panel of *Challenge Golf* can display nine different holes from a bird's-eye view. Each hole has different combinations of hazards and surrounding terrain. That panel also displays the relative position of the ball as you hit it down the fairway. The bottom screen is a TV-camera-angle view of the golfer and surrounding area. A single button controls the backswing (you see the club and arms in several positions through the swing) and the instant the ball should be hit. A late or early hit will slice the ball into the rough. Six screens depict the golfer at different positions along the hole; at the tee, down the fairway, and at a few distances from the pin. A digital score-display lets the player know the distance from the cup in meters to help in judging the power he should use for the next stroke. At under $40, this game is quite a value.

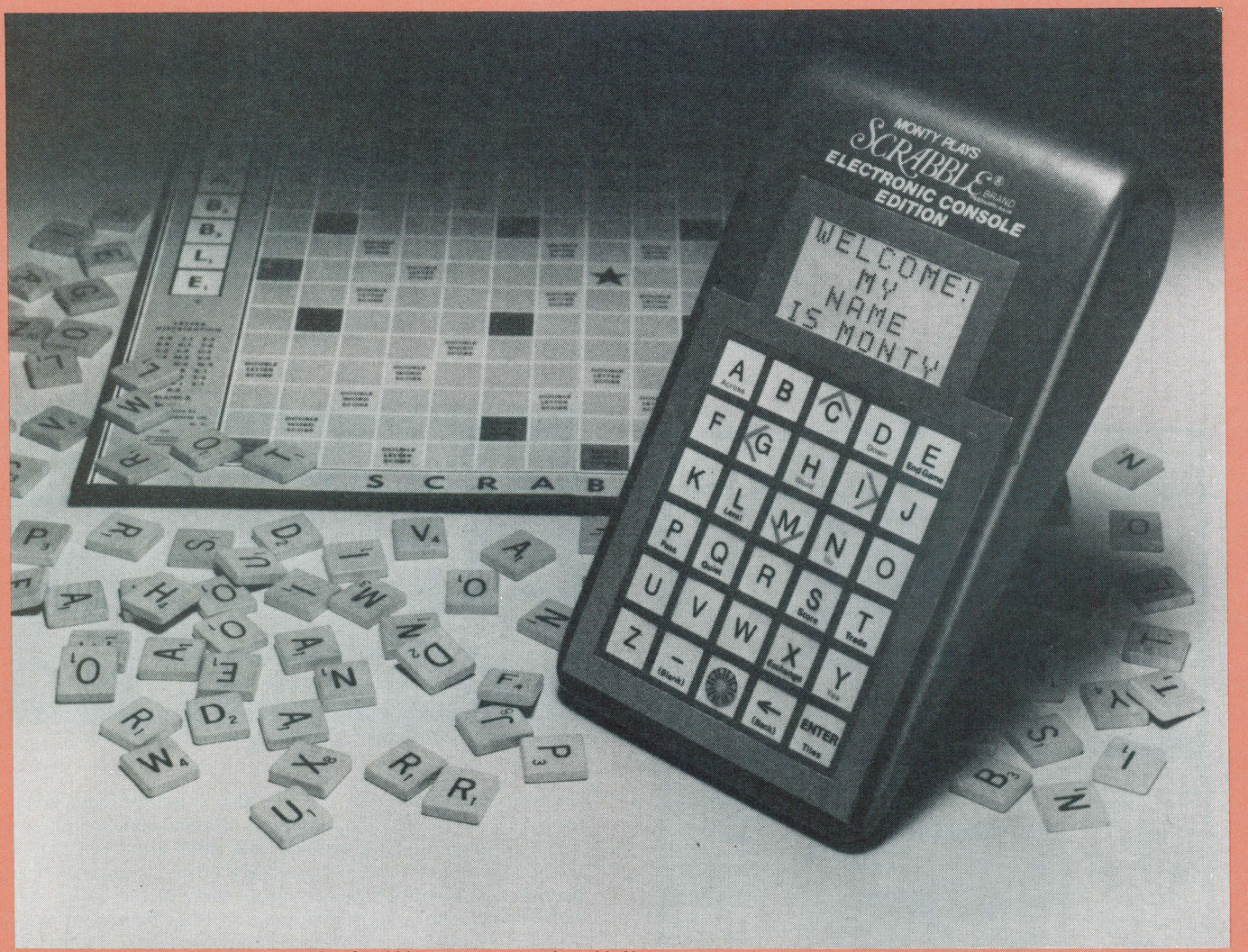
Arcade hits

In the tabletop-game area, arcade titles still dominate the action. Coleco has added a few new "hot" titles to its impressive, though expensive, collection of tabletop arcade games.

Ms. Pac-Man is properly decked out in the multi-colored vacuum-fluorescent display with a red ribbon. As in the original, the bonus fruit (cherries) are on the move through the maze. In addition to the standard game, the Coleco version includes a two-player, head-to-head game, in which players try to outdo each other in scoring points for gobbling dots, monsters (when Ms. Pac-Man is properly energized, of course) and bonus fruit.

Donkey Kong Junior was sure to follow on the heels of *Donkey Kong*. In Coleco's version, "Junior" is a solitaire game only, with two different multi-colored vacuum-fluorescent screens.

One of the most graphically difficult games to reduce to a home version is the three-dimensional space adventure, *Zaxxon*. In Coleco's new vacuum-fluorescent-display tabletop edition, a visual perspective similar to that of the original is retained. There is no scale along the left edge to guide you to the proper altitude, but with some practice, you will be able to identify your position within the range of movement available to you.



YOU NO LONGER need a partner to play *Scrabble*—now you can play with *Monty*.

Parker Brothers will also get in the tabletop arcade action with an adaptation of the hilarious *Qbert* game. *Qbert* will sell for about $60.

Three dimensionality is Tomy's goal in their new series of 3-D games. Each is housed in a binocular-styled case. All three games, *Planet Zeon, Thundering Turbo,* and *Sky Attack* have multicolor displays whose designs recede to a single focal point, creating the 3-D illusion. Most of the player action involves simply moving your ship or car left or right to avoid oncoming obstacles, and firing shots with buttons on the top of the case. The games, which will be priced under $50, need to be played under an external light-source.

Invisible chess

If your electronic-gaming preferences lean toward more strategic endeavors, computer-chess games are more likely your style. Of the few new chess games this year, the most striking is surely Milton Bradley's *Grand Master*.

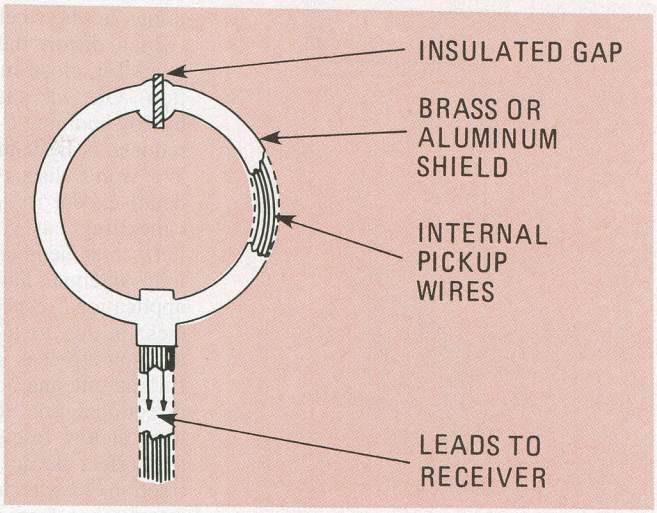
You may have seen robot chess games before, in which the chess computer, in response to your move, activates a mechanical arm to pick up a piece and move it to the appropriate square. While you may not understand all the computer wizardry going on inside the game, at least you can see your "opponent" move his piece almost like a human player. But with *Grand Master*, there is no robot arm. The computer's pieces merely slide along the board from one square to another. It's like playing chess with the Invisible Man. The game offers twelve skill-levels, and some features you don't find on any other games. If you want the computer to give you a hint for your next move, it will wiggle the piece you should use. The computer also stores the moves for the entire game in its memory so you can watch the pieces go through a replay of the last match. And unlike robot games that have sold for well over $1000, Milton Bradley hopes to offer its marvel for around $500.

Computer Scrabble

There is hardly a traditional board game that has been ignored by electronic designers. *Monopoly* has been computer-enhanced since last fall. Now, *Scrabble*, one of the all-time-favorite word games, has two electronic editions that allow solo play. One is available as a program from the *Applie II* and *Apple II + computers*. In that version, the entire board is shown on the video monitor.

The other version, called *Monty Plays Scrabble* (Monty is the computer), is a tabletop unit. An LCD screen acts as a "window" to an entire *Scrabble* board, which Monty remembers. Letters are supplied to the human player at random (from the usual assortment of tiles). When you've formed a word, you can scroll around the board to place it where it will earn the most points. Monty does the same, but he has the advantage of a built-in 12,000 word dictionary. Additional modules of 16,000 words are also available. Monty keeps score (he knows where all the bonus squares are). *Monty Plays Scrabble* really needs to be played with either a standard *Scrabble* board, or with the printed paper pads available from Selchow & Righter. All in all, it's a clever and engrossing translation of a time-tested game. Such sophistication won't be inexpensive, however. Monty is priced at around $125. **R-E**

LOOP ANTENNAS FOR VLF-LF



A discussion of low-frequency reception would not be complete without mentioning loop antennas—the subject of this article.

R.W. BURHANS

Part 5 IN PARTS 1, 2, 3, AND 4 of this series (in the February through May issues of **Radio-Electronics**), we covered several aspects of low-frequency receiving techniques, including the design and construction of an active-antenna system using a vertical whip. This time we'll discuss a different type of antenna—the loop. While this isn't exactly a construction-type article, the ambitious reader will find that he can make his own loop-antenna system using the information presented.

Perhaps the most important difference between loop antennas and the whip antennas that we have previously discussed is the loop's directivity. (The vertical whip is, of course, omnidirectional and cannot indicate the direction from which a received wave comes.) Before we can talk more about this directive property, we have to take a look at how an electrical signal is induced in the loop by a passing electromagnetic wave, and at some general electrical characteristics of loop antennas.

Loop-antenna characteristics

A current is set up in a loop antenna by a changing magnetic field. (That current is equal to the integral of the electric field that is induced around the loop.) The sensitivity of a loop is directly proportional to the loop area and to the number of turns in the loop. It is, in general, inversely proportional to the wavelength of the signal. Small receiving loops for 60 kHz (WWVB) require a preamplifier with a voltage gain of 30 dB or more to make them comparable in performance to a small active whip-antenna.

The inductance of the loop winding itself makes loop antennas frequency-sensitive. Because of that, it becomes difficult to make such antennas with wide-band characteristics. To increase the sensitivity of a loop, multiple-turn coils are used at the VLF–LF range. However, the distributed capacitance of the windings acts with the loop's inductance to decrease the antenna's frequency response. That, however, is not always a disadvantage. The frequency selectivity of a loop winding is often an advantage in that it can provide for rejection of out-of-band signals (in other words, it can form a sharply tunable antenna-system). Loop-antenna systems seldom have intermodulation-distortion problems because of their lower sensitivity, lower impedance level, and better selectivity.

Directivity of loops

Perhaps the most significant and valuable property of loop antennas is the fact that they can be used to determine the direction of an arriving signal. Let's look at how they can do that. Consider a loop and a vertically polarized passing electromagnetic wave as shown in Fig. 1-a. A voltage will be induced in the vertical members of the loop, but none in the horizontal ones. If the voltages induced in each vertical member are the same (as they would be if the plane of the loop were perpendicular to the direction of travel, Z, as shown), then no current will flow. However, if the plane of the loop is parallel to the direction of travel of

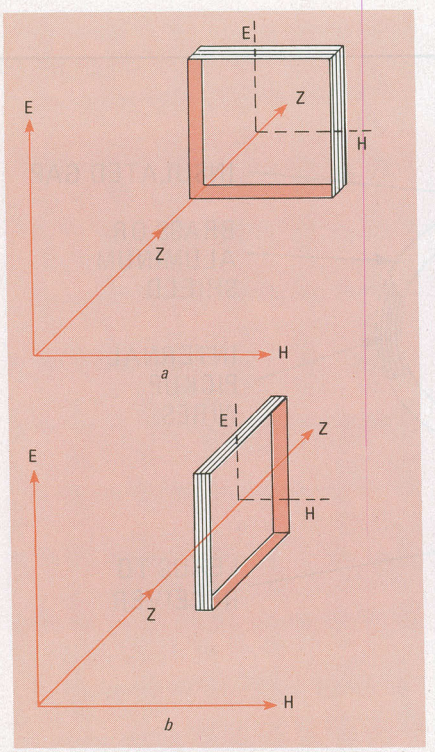


FIG. 1—AN ELECTROMAGNETIC WAVE can be described by its electric component (E), magnetic component (H), and direction of travel (Z).

the oncoming wave, as shown in Fig. 1-b, then the wave will reach one side of the loop before the other, the total voltage around the loop will not be zero, and current will flow. The voltage induced in the vertical members is proportional to the height of the loop, and the voltage difference between the vertical members is proportional to the width of the loop. Therefore, the voltage around the entire loop is proportional to the product of its height and the width—that is, its area.

Another way of reaching the same conclusion is to say that the voltage induced around the loop is proportional to the rate of change of the magnetic-flux linkages through the loop. Then it is obvious that the area of the loop is the controlling factor, and the loop will receive the most signal when its plane is normal (perpendicular) to the magnetic field (H) of the oncoming wave (or in the same plane as the direction of travel of the oncoming wave).

Direction-finding shortcomings

The directional properties of loop antennas that we have just described permit you to null out interference or to obtain a broad peaking of a signal merely by rotating the loop. However, loops, though they are often used because of their relative simplicity, are not ideal direction-finding antennas.

Loops cannot distinguish between signals that arrive from opposite directions (for example, north and south). Another drawback is that trying to determine the source of a signal that arrives at an angle different from that of the ground wave (not exactly head-on) will usually result in an error. Ground waves themselves frequently arrive "tilted." That tilting is often due to the magnetic effects of such things as the steel I-beams of buildings (which distort the boundary conditions even for close-in ground-wave reception). One way that the problems caused by downcoming ("tilted") waves can be reduced is by using an *Adcock* antenna. We won't discuss that antenna in any detail except to say that it operates by cancelling out voltages induced in its horizontal members. A third problem that loop antennas have in direction-finding applications, especially at low frequencies, is due to the *antenna effect*. The antenna effect is seen when a direction-finding antenna acts like a simple, non-directional one. Loop antennas, when used at low frequencies, are subject to that effect because their size is only a fraction of a wavelength, and they pick up interference from a signal derived from the electric, rather than the magnetic, field. A loop's symmetry should ideally cause that signal to be cancelled out, but in real systems the effect is often the source of problems.

Resolving those problems

If you were to turn a loop antenna through 360° and observe the strength of the signal received, you would obtain a reception pattern that looked like a figure-8. Such a pattern leaves you with a 180° uncertainty as to which direction the signal is from. That uncertainty can be resolved by using a whip antenna in conjunction with the loop to cancel one of the lobes of the figure-8 pattern. That is done by coupling the output of the vertical antenna to the loop so that the voltage induced in the loop by the coupling is 90° out of phase with the voltage the passing wave induces in the vertical antenna. Figure 2 shows the cardiod directional pattern that results from combining the figure-8 with the omnidirectional pattern from a whip. The sense of the incoming signal is usually determined by rotating the loop to cancel one of the lobes of the figure-8. In practical systems it is necessary to provide some phase- and amplitude-balancing between the two antennas.

To reduce the antenna effect that distorts the loop's directional pattern, and to obtain the best performance (in terms of detecting sharp nulls and uniform amplitude-peaks as the loop is rotated), the loop should be mounted within an *electrostatic shield*. That arrangement balances the loop by making sure that all parts of it will have the same capacitance to ground. That shield or cavity also protects the loop from the *induction field* created by nearby disturbances. The induction field refers to the electric and magnetic fields in the immediate vicinity of an antenna. Those fields decrease

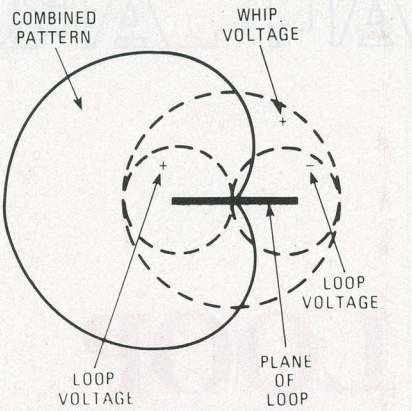


FIG. 2—A WHIP ANTENNA combined with a loop antenna can remove the ambiguity as to the sense of the oncoming wave.

rapidly in strength with distance, and the induction field is usually ignored (and the *radiation field* is all that is considered). However, wires and other metal objects near the loop can take energy from a passing wave and produce induction (and radiation) fields that can induce spurious voltages in the loop.

A shield over a loop antenna (one type of shielded loop is shown in Fig. 3) will not appreciably decrease the amount of magnetic flux that passes through (and links with) the loop when a wave goes by—as long as it does not form a complete (shorted to itself) turn. An insulated segment or gap is always left in the shield so that it does not become a shorted turn. Without the gap, the shield would form a shorted turn and it would reduce the magnetic field linking the loop so that no signal could be received by the internal wire(s). With the insulated segment or air gap, alternating currents can be induced in the metal shield (but no current will flow), and voltages will be induced in the internal wire(s). Some experimenters have wound loops inside slit *Hula-Hoops* and then shielded them by wrapping the outside with aluminum tape, leaving a gap in the tape at the top of the loop. Ferrite-core loops (which we will discuss shortly) are usually mounted axially in a trough or U-shaped channel (with the top and ends open to prevent a shorted turn) for electrostatic shielding.

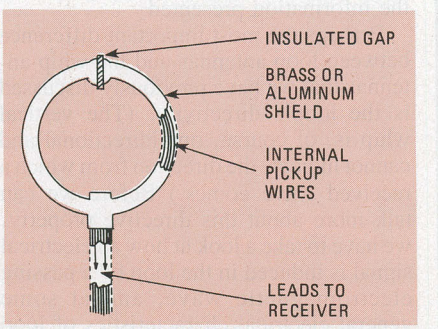


FIG. 3—AN ELECTROSTATIC SHIELD can improve the performance of a loop.

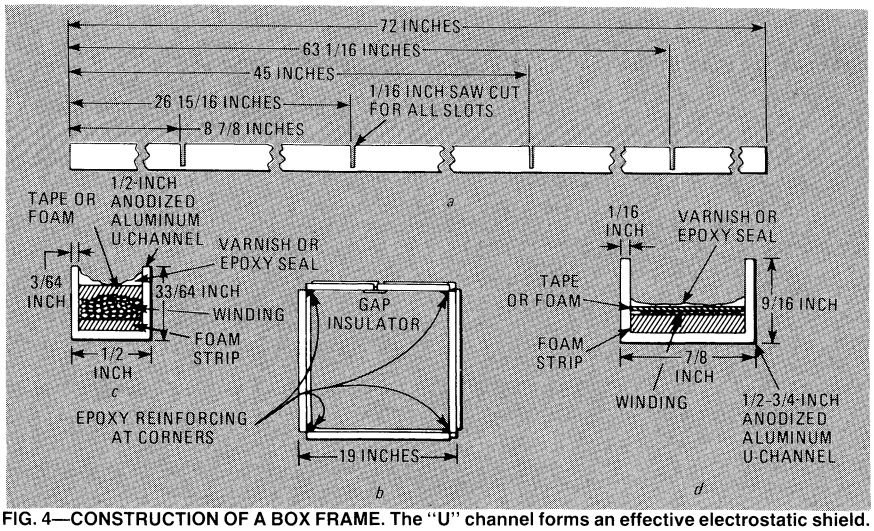


FIG. 4—CONSTRUCTION OF A BOX FRAME. The "U" channel forms an effective electrostatic shield.

A method for making a square box-frame loop is shown in Fig. 4. A long length of U-channel aluminum is formed into into a box frame by cutting slots into the side of the channel and then bending the material. A small gap with a plastic insulator in it is left at the top of the frame; the insulator holds it together and prevents it from forming a shorted loop. The coil winding is supported on plastic foam, just below the outer edges of the U-channel.

Winding loops

The distributed capacitance of the loop may, especially at low frequencies, cause the current to vary at different points on the loop and cause deviations in the directional pattern. A technique for reducing the distributed capacitance of the loop windings is to make the loop in a *mobius* form. A mobius loop is one where the coil is "twisted" so that (except at the start/finish point where the wires cross) all the "even-numbered" turns are adjacent to one another, with the same being true for the "odd-numbered" turns. The distributed capacitance of the mobius-type antenna shown in Fig. 5 is about one-half that of the antenna illustrated in Fig. 4—even though both contain the same number of turns. The mobius-wound antenna also has a wider bandwidth.

Effective length

When we discussed active-antenna systems, we frequently mentioned the *effective length* of an antenna (often referred to as *effective height*). We can also talk about the effective vertical length of a loop antenna. An approximation for computing the effective length, l_e, of loop antennas is:

$$l_e = \frac{2\pi\ nA\ \mu_r}{\lambda}$$

where λ = the wavelength in meters; n = the number of turns in the loop; A = the cross-sectional area of one turn in meters^2; μ_r = the effective permeability of the core material (= 1 for air core); and $\lambda = 3 \times 10^8$/frequency in Hz.

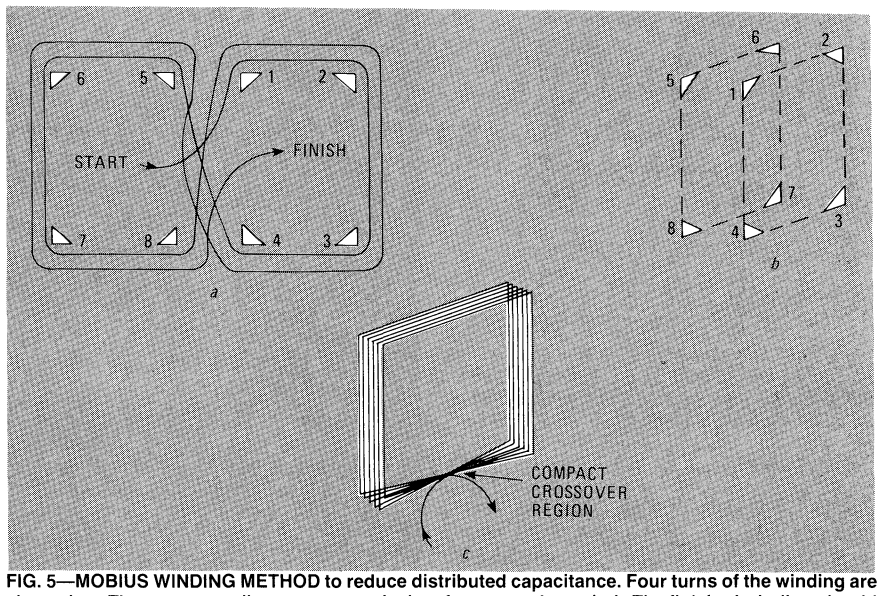


FIG. 5—MOBIUS WINDING METHOD to reduce distributed capacitance. Four turns of the winding are shown in *a*. The corresponding corners on the box frame are shown in *b*. The finished winding should look like *c*.

Small-size ferrite-core loop antennas

It is often useful to consider the smallest practical size of loop antenna that can be used, say for reception of signals such as those from WWVB at 60 kHz. Using a ferrite core increases the effective permeability of the core and, as you can see from equation 1, that increases the effective length. Ferrite cores are available commercially in several different permeability ranges. Figure 6 is a chart that illustrates the effective permeability of a ferrite rod compared to the bulk permeability of the ferrite material.

The whole idea of using a ferrite-rod core is to increase the magnetic flux density through the loop. For the maximum effect, you want to have as much of the core exposed to the winding as possible. Compact, multiple-layer coils in the center of a long core-rod are never as sensitive as a single-layer coil that covers almost the whole length of the rod. Unfortunately a long coil has a problem in that the distributed capacitance of the coil winding is quite high, and the Q of the long coil will not be as good as a coil with a better "shape-factor" (smaller length-to-diameter ratio). To maximize the coil's sensitivity to the magnetic field in space, the product of the number of turns and effective permeability of the rod should be as large a number as possible. From Fig. 6 it can be seen that the whole length of the rod should be used to maximize the effective permeability. Another factor to consider is the effect that the ferrite material used has on the Q of the coil. (At low frequencies, the maximum Q that can be obtained depends on the core material, its size, and the signal frequency.) Figure 7 describes the effect on Q for an 800 μ bulk-ferrite-material rod that measures ½

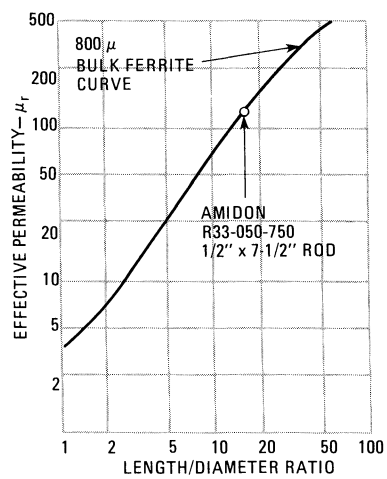


FIG. 6—THE PERMEABILITY of a ferrite rod does not depend only on the permeability of bulk ferrite, but also on its length and diameter.

TABLE 1—Loop Antenna Comparisons

Antenna Materials	Square air frame Aluminum channel 6 feet × ½ × ½ inch	Square air frame Aluminum channel 6 feet × ½ × ¾ inch	Small ferrite rod Amidon 800 μ rod with trough shield	Small ferrite rod Amidon 800 μ rod with trough shield	Small ferrite rod Amidon 800 μ rod with trough shield	Small ferrite rod Amidon 800 μ rod with trough shield
Coil size	18½ × 18½ inches multiple layer	18½ × 18½ inches single layer	7½ × ½-inch solenoid	7½ × ½-inch solenoid	7½ × ½-inch solenoid	7½ × ½-inch solenoid
Turns wire	46, No. 28 stranded Teflon insulated	43, No. 28 enamel	555—270 left-hand 285 right-hand, No. 30 enamel	555—270 left-hand 285 right-hand, No. 30 enamel	555—270 left-hand 285 right-hand, No. 30 enamel	555—270 left-hand 285 right-hand, No. 30 enamel
Inductance	2.6 mH	2.5 mH	6.9 mH	6.9 mH	6.9 mH	6.9 mH
Capacitance	290 pF (distributed capacitance)	145 pF (distributed capacitance)	330 pF (distributed capacitance)	330 pF + 27 pF (distributed + external capitances)	330 pF + 680 pF (distributed + external capitances)	330 pF + 39000 pF (distributed + external capacitances)
Resonance	180 kHz	275 kHz	107 kHz	100 kHz	60 kHz	11 kHz
Effective Height	2.5 cm	2.5 cm	1 cm	1.4 cm	.88 cm	.16 cm

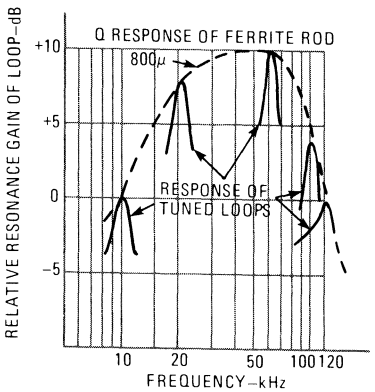


FIG. 7—THE RESPONSE OF A LOOP ANTENNA depends upon the response of the core as well as the response of the loops wound on the core.

FIG. 8—AN ACTIVE ferrite-core loop antenna in its trough shield.

× 7 × ½ inches. It also describes the antenna's response with and without external capacitances added. The winding properties of the ferrite-core loop are included in Table 1, and Fig. 8 shows the ferrite-core loop-antenna itself.

Comparing loops

The comparative properties of a ferrite-rod antenna and the two air core box frame loops (shown in Figs. 4 and 5) are shown in Table 1. The scramble-wound box loop, which is in a slightly smaller U-channel, has a higher winding capacitance that results in a resonant frequency of 180 kHz. The mobius flat-wound loop has only half the winding capacitance and almost the same inductance. That results in a higher resonant frequency of 275 kHz. Both of the air-core box loops are intended to be operated in the wideband mode with no external tuning-capacitance. The mobius box-frame loop has exceptionally deep nulls of 40 dB or more in the 60-kHz to 100-kHz frequency range. The ferrite-rod loop is intended for fixed-frequency use (tuned to 60 kHz with an external tuning-capacitor) for WWVB reception. Similar ferrite loops (where the loop coil and housing is different for each frequency band) that cover a wider frequency range are available commercially from several sources.

For an untuned box-loop, the upper-frequency limit is determined by the self-resonant frequency of the coil and its distributed capacitance. The effective length is greatest at that point, and it decreases by a factor of 10 or so at the 10-kHz low-frequency end. The box loop can also be tuned by placing a tuning capacitor in parallel with the loop coil. That will increase the Q, but a preamplifier with a higher input-impedance will be required. The best power transfer from the loop coil to the preamplifier is usually obtained when the loop impedance and the preamplifier input impedance of the preamplifier are in the same impedance range—which is not at highest Q. In designing loop antennas there is always a compromise to make between selectivity and sensitivity. An untuned loop with a rather broad self-resonant frequency peak (which is the case for the flat mobius-coil box-loop) provides the best sensitivity and also the deepest nulls of the antennas compared in Table 1.

Balanced loops

As we discussed previously, to obtain the best null-performance, loop antennas should be operated so that the capacitance between the antenna and electrostatic shield is the same at all points along the loop. With a single winding that's a problem, since one end of the winding has to be grounded in some way. A loop with a center-tapped winding is often used together with a preamp with a balanced input, but there is a better way of winding loops on long ferrite-rods that also reduces the inductance of the whole winding and results in a single-ended terminal for the loop.

The technique, developed by the U.S. Army Signal Corps many years ago, involves making right-hand- and left-hand-sense windings starting at the center of the core. The resulting loop, shown in Fig. 9, still has opposite-phase nulls off opposite

ends, but now has excellent electrostatic symmetry with respect to the trough shield. (The ferrite-core loop discussed earlier was a balanced loop.) The sensitivity of this coil is about the same as that of a coil wound in a single direction from one end to the other, but the inductance is reduced, resulting in a higher self-resonant frequency. The termination point in the center of the core practically eliminates induction-field noise-pickup, even with a single-ended preamplifier system. When winding a coil with a relatively large number of turns, it is advisable to check the winding for inductive balance because the ferrite core material may not be uniform from end to end. Another factor contributing to nonuniformity is that it is difficult to wind a perfectly spaced coil by hand. That is why the figures indicating the number of turns on each side of the antenna described in Table 1 are different.

To tune the balanced-loop coil arrangement shown in Fig. 9 to resonance at 60 kHz, a fixed capacitor of about 500 pF can be placed in parallel with a small variable capacitor of up to 350 pF (and the 330-pF distributed capacitance of the coils). That allows the total capacitance to be set to about 1000 pF—the capacitance required for resonance with the 6.89-mH inductance indicated in Fig. 7.

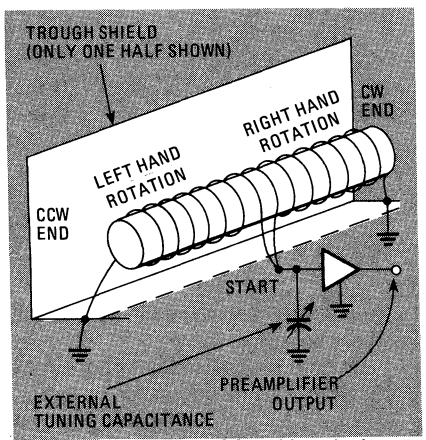


FIG. 9—A BALANCED LOOP with a single output can be made by using the left-right winding technique shown here.

Balun method

Another technique for making the capacitance of a single-winding loop symmetric with respect to the electrostatic shielding is to employ a toroidal balun (*BAL*anced-line to *UN*balanced-line) transformer between the loop winding and the preamplifier. That technique is illustrated in Fig. 10. The balun is used with the air-core box loops shown in Fig. 4, which have no center tap on the loop windings. The trifilar-wound transformer consists of about 30 turns of No. 30 insulated wire-wrap wire twisted 6 to 8 turns-per-inch and wound on an Amidon (12033 Ostego St., North Hollywood, CA 91607) FT82-75 high-permeability ferrite core. That makes the loop coil, which is a balanced source, look like an unbalanced source to the preamplifier. Baluns can also be used with ferrite-core antennas wound in a single-direction (instead of the right-left method of Fig. 9.)

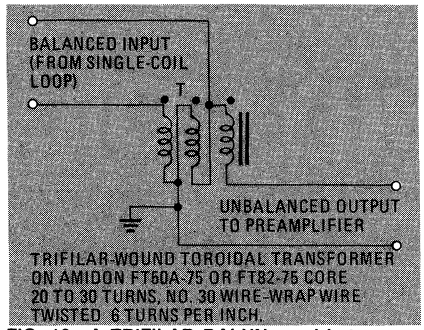


FIG. 10—A TRIFILAR BALUN used between a balanced loop and a preamplifier with an unbalanced input.

Loop antenna locations

Loop antennas are much less sensitive than small whips, but they have the advantage of having more selectivity as well as having directional null- and peaking- properties. It's a good idea to place a loop in the attic of a house well away from the electrical appliances and power lines, and to keep it away from major steel structural members (which, distort the local magnetic field).

High-gain preamplifier

When designing an active-whip antenna, we considered the whip to be a voltage source with a high internal impedance requiring current-amplification, and (to reduce attenuation due to a mismatch) we wanted the preamplifier also to have a high input-impedance. However, with a loop antenna, which is considered to be a low-impedance current source, we want a low-impedance voltage amplifier.

Almost all LF loop antennas will require a preamplifier with a voltage gain on the order of +30 dB. Low-noise performance is more important here than with whip antenna preamps because of the lower signal levels at the loop terminals. There is a great variety of circuits possible, but one of the simplest uses a power-FET or VMOS-FET like the one shown in Fig. 11. That preamp should be mounted directly at the terminals of the loop in a weatherproof shielded box or inside of a trough shield (with the balun transformer, if required). The output of the amplifier is fed (through a coaxial cable) back to the same receiver coupler that we used with the active antennas described in previous articles. The gate-bias voltage-divider trimmer potentiometer is adjusted so that the operating current of the receiver coupler is about 40 mA. The VMOS transistor used can be the Siliconix VN10KM. You can also use an ITT BS170—which has properties similar to those of the VN10KM, but a different pinout. The series resistor for the gate bias, about 15,000 ohms, is chosen to approximately equal the reactance of the loop coil at the highest or cutoff operating-frequency. If a tuned loop coil with a higher Q is used, then the value of the resistor should be increased in value to 100,000 ohms or so. The output transformer can be the primary winding (about 200 or 600 ohms) of a subminiature or ultraminiature audio transformer. The secondary can be left open for operation up to the 500-kHz region. At higher frequencies, a bifilar toroid—such as the one wound on an Amidon FT50-75 core for the wideband active whip preamplifier—can be used as an output transformer. The preamplifier will have a voltage gain of about 30 dB when driving a 50-ohm load at the receiver coupler.

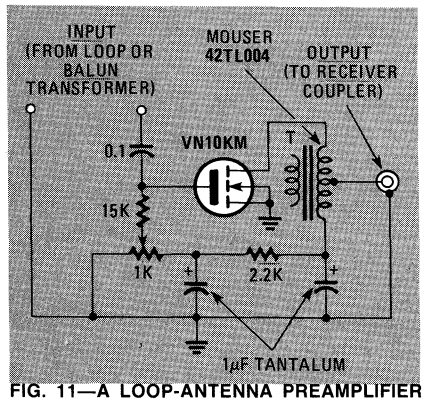


FIG. 11—A LOOP-ANTENNA PREAMPLIFIER used for a frequency range of 10 kHz to 500 kHz. The transformer is a audio-output transformer—200 ohms center-tapped: 8 ohms center-tapped. No connection is made to the secondary.

Bench testing loops

You can evaluate the resonant frequency of a small loop-antenna system by connecting a coupling coil and a 50-ohm load resistor in parallel as a termination at the end of a coaxial cable from a signal generator. For low-frequency testing (below 500 kHz) the coil can be a 1-mH pi-wound RF choke. The probe is brought very close to the loop under test to inject a small amount of signal by magnetic or inductive coupling. The output from the loop and/or a suitable preamplifier are then observed (either on an oscilloscope or a receiver) as the signal generator is tuned over the desired frequency range. The coupling sensitivity of both the probe coil and the loop will decrease at lower frequencies. This simple magnetic probe will allow you to obtain a good idea of the loop resonance and its general performance. You can also estimate the loop inductance by placing known capacitors in parallel with the antenna and then observing the response. The coil's distributed capacitance can be estimated by computing the difference between the resonant frequencies of the loop with and without the added tuning capacitance. **R-E**

HOBBY CORNER

Following the sun

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

I WANT TO THANK ALL OF YOU FOR THE great response to our invitation to send in your questions related to hobby electronics. The amount of mail has been very gratifying.

Just because I have a backlog of questions, however, don't hesitate to send any more that you may have. And don't forget to send in any circuits and/or applications that you have found useful. Those chosen for use here are not printed in the order that they are received. One could come in tomorrow and go immediately to the top of the list. It depends entirely on the nature of the inquiry or circuit/application.

How are your letters chosen for Hobby Corner? It's quite simple and straightforward: the highest priority goes to those that I feel will be of the greatest interest to the largest number of readers.

Unfortunately, some of the items that seem to fit that requirement cannot be used. I am flattered by some of the questions that have appeared in the mailbag. They indicate tremendous confidence in me and the others here at **Radio-Electronics**. However, there is no way we can come up with a design for a circuit that is simple to build, has a parts cost of no more that $15, and works better than the $195 commercial unit you would like to have! We wish we could help, but there *are* limits!

AN INVITATION

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

Hobby Corner
Radio-Electronics
200 Park Ave. South
New York, NY 10003

Following the sun

Mark Zilm (CO) sent a nice letter in which he asked for suggestions for a method of automatically tracking the sun with a solar collector. Well, Mark, the task isn't all that difficult unless you need to track the sun precisely. Fortunately, such precision is seldom necessary.

I'll outline an approach to the problem and most readers can fill in the details for themselves. If enough of you need additional help, we'll work it out together here in a future column.

Let's see just how much we can simplify the requirements. First, the collector need be moved in only one plane if it is mounted on a polar axis. Then, all you have to do is to turn it clockwise (as seen from the top) to follow the sun as it moves from east to west. Of course, that suggests that a mechanical clockwork affair could be rigged up to do the turning. However, let's stick with electronic control if for no other reason than it's more fun!

Next, because it is a *solar* collector, we know that it is not necessary to have it continue to turn after sunset. It should stop when it points west in the evening and start up in the morning pointing east. I will assume that it is no great hardship to point the thing manually toward the east each morning. (That can be done electronically, too, if necessary.)

Finally, let's assume that you don't want to have to throw an OFF switch when a cloud passes in front of the sun, in the evening, or on cloudy days, to keep the thing from "hunting" for the light. If you can live with those assumptions, at least for now, we'll proceed.

Take a look at the block diagram shown in Fig. 1. There you see a light detector that controls how much voltage is applied to a motor. It is rigged so that the *presence* of light on the detector closes the circuit and causes the motor to run. What kind of a setup could that be?

A bit of thought shows that the whole operation is quite similar to the action of one of those devices that turns a light on when it gets dark. The main difference is that we don't care about turning on a light; we want to run a motor. We can use a commercial night-light controller to do the job if we have it operate a relay to run the motor when the light is on it (rather than when it is in the dark). Such a setup would work but it would be difficult to adjust properly.

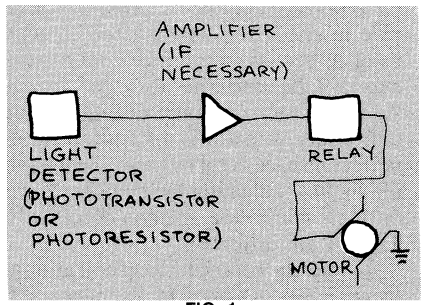


FIG. 1

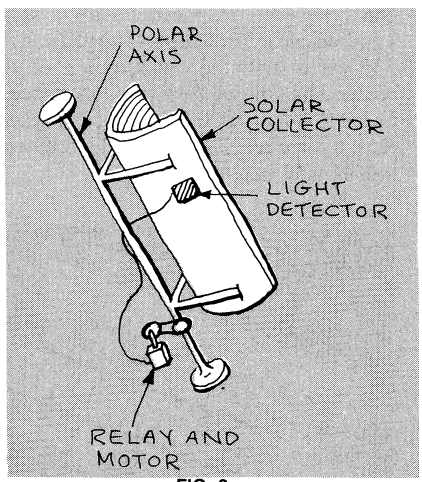


FIG. 2

Instead, let's use a phototransistor or a cadmium-sulfide photoresistor as the detector. Either one can be set up to operate a relay to handle the higher voltage/current demand of a motor.

Let's attach a motor to the collector so that when it runs, it turns the collector to the west on its polar axis. Next, attach the detector to the west side of the collector so that it is in collector's shadow when the entire device is pointed at the sun (see Fig. 2). As the sun moves west, it reaches a point where it shines on the detector. When that happens, it triggers the relay, which in turn causes the motor to run. That, of course, turns the collector. But when the collector turns far enough west, so that it's pointing directly at the sun, the detector is shaded, which turns off the motor!

What could be simpler? Every five minutes to an hour, depending on exactly where the detector is attached to the framework, the motor turns the collector

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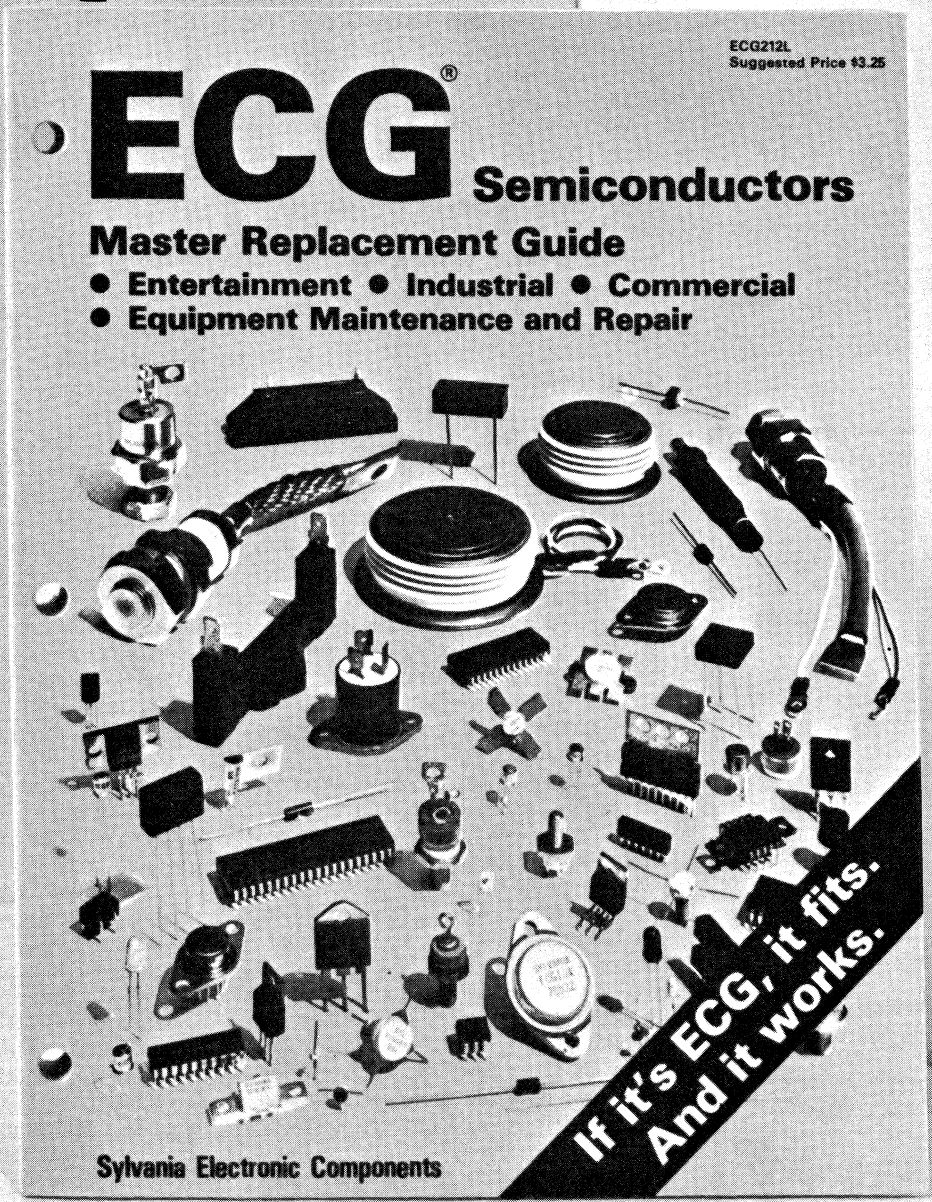

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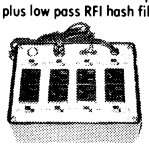

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until it is pointing at the sun once again. Of course, you can put "blinders" around the detector as needed.

What happens at sunset? No light shines on the detector so the motor stays off. How about clouds? The same thing—When a big cloud obscures the sun, the collector remains motionless until it passes. Even if the sun doesn't come out again until hours later, when it does, the motor simply cranks the collector around until it is pointing at it and the detector is in shadow again.

Well, Mark, there you have it—a pretty crude control, but one that works. All you have to do is to turn the collector back toward the east in the mornings. If that is too much trouble, rig another detector and motor, or timer and motor, to do the job for you.

You should be able to take it from there.

Good ideas

But getting back to some of your letters, it seems there's no shortage of really good ideas for this column. How about a simple gadget to put the date and time on the screen of a TV set? Or how about ones to add "last number redial" or a display of the number dialed to any telephone? Well, gentle readers, those things can be done, but not with a handful of parts—unfortunately. And we wish we did have the resources to design a robot that could talk, see, and be programmed for various duties such as greeting guests and acting as a watchdog.

I'm exaggerating a bit, but you get the idea. There are, of course, many interesting things on the "coming up" list and we're looking for more. For now, let's tackle a couple of shorties.

To the reader who is looking for an "audio transmitter" to use for remote control of garage doors and models: be advised that the simplest audio transmitter is the human voice—just yell in the direction of the receiver. In addition, you may want to try a whistle, a clap of the hands, or a plain old audio oscillator and amplifier. Be advised further, however, that the device being controlled is quite likely to respond to sounds over which you have no control. The folks who had the early garage-door openers that operated every time a plane flew overhead had it easy compared to someone whose audio-controlled door flew open every time a car passed on a busy street.

For Ronald Cadman (CT) who is looking for a light-sequencing circuit: check the Hobby Corner in the March 1978 issue of **Radio-Electronics**. There you'll find several IC circuits for building a sequencing or traveling light device. They can be cascaded for any practical number of lights. The lights can be LED's, or incandescent lamps if you use the proper driving relays/transistors.

For Joe Guillette (CT) who needs help in identifying leads on a power transformer: there is a color code that used to be used on such leads. It is an old one and is most often honored by being ignored; many manufacturers now use their own codes, which doesn't help us a bit.

Just in case your transformer follows the code, it goes like this. First, the primary winding is designated by black insulation. An untapped primary has two black leads. A tapped primary's leads are black and black-red (black with red stripes), with black-yellow for the tap.

Each secondary winding is indicated by two wires of the same color. Red is the high-voltage winding; yellow is the low-voltage winding (usually 5 volts), and other secondaries may be green, brown, or slate. A yellow stripe indicates a tap (usually a center tap) on a winding. Thus, a center tap on the high-voltage winding is red-yellow, and others follow the same pattern except, of course for the low-voltage winding. Yellow-yellow would be meaningless so that insulation is yellow-blue.

Again, I remind you that those codes are not often used these days. (I had to refer back to a 1956 publication to refresh my memory on the colors.) If the codes do not help, the Hobby Corner that appeared in the April 1979 issue of this magazine contained a rather extensive treatment of how to identify unknown power-transformer leads. In any case, be careful as you work out that problem.

For Jim Marting (NY) who is looking for information on the SN76477 sound-generator IC: Sorry, but space does not permit going into the details of that fascinating device at this time. Take a look at the Hobby Corner columns that appeared in the February and April 1982 issues of **Radio-Electronics**. You should be able to get a good start with the information there.

Before leaving the subject of old Hobby Corner columns, let me give a quick response to those of you who have asked how to get started in this hobby electronics field. In a nutshell, do some experimenting with circuits you find in magazines and books; read the articles carefully and you'll understand a bit more with each one; it's also a good idea to get hold of a few basic books and study them carefully. **R-E**

"You said this computer would pay for itself so collect from it!"

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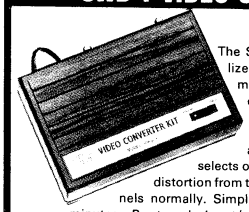

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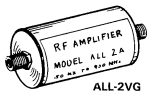

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ALL-2VG Wired and Tested. **$49.95**

Switch to Bambi™!
Electronically

Bambi Electronic Video Switch ... makes switching of your VCR/VTR, Pay TV Decoders, Cable TV, Video Discs, Video Games, Closed Circuit TV, Antennae and Microcomputer as easy as pushing buttons.

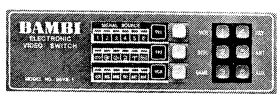
The Bambi Electronic Video Switch is an electronic computerized switching network with memory which can accept up to six different sources of video signals and provide the flexibility of directing the inputs to any or all of the three outputs.

Now you can eliminate ... the drudgery of disconnecting and reconnecting your video equipment each time you use it ... the tangled mess of cables which are impossible to trace out ... not being able to use more than one function at a time.

Bambi lets you enjoy using your video equipment the way it should be ... electronically and on line at the push of a button.

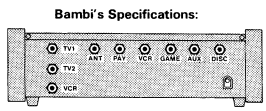
Model BEVS-1 Completely Wired and Assembled. Includes comprehensive Instruction/Operation Manual and Decal Set for customizing your Video Switch installation. **$129.95**

FREE Bambi Poster with any purchase

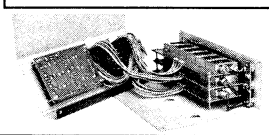


Bambi's front panel was designed with the user in mind. Computer styled construction, with soft-touch keyboard (rated for over 10 million operations), arranged in matrix form allows easy input/output selection without refering to charts. Functions selected through the keyboard are immediately displayed on the 18 LED status indicators.

Bambi's Specifications:

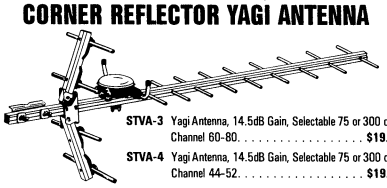


Input/Output Impedance	75 ohm
Signal Loss	3dB ±1dB
Noise	4dB ±1dB
Input Return Loss	12dB min.
Isolation	65dB min.
Power Req.	117VAC 60 Hz, 2W
Dimensions	10¼ W x 6¾ D x 3⅛ H
Weight	4½ lbs



Check the quality of Bambi against that of much higher priced competition. All solid state electronic switching provides low attenuation (3dB), wide frequency response (40-890 MHz), and excellent isolation between signal sources (each I/O section individually sheilded for 65dB min. isolation).

Our New STVA 14.5dB GAIN, 14 ELEMENT CORNER REFLECTOR YAGI ANTENNA



STVA-3 Yagi Antenna, 14.5dB Gain, Selectable 75 or 300 ohm Channel 60-80. . . . . **$19.95**

STVA-4 Yagi Antenna, 14.5dB Gain, Selectable 75 or 300 ohm Channel 44-52. . . . . **$19.95**

RG-59/U 75 ohm Low Loss Coax Cable. . . **$.12p/ft.** **F-59** Coax Connector. . . **$ .39 ea.**

MT-1 Special UHF 75-300 ohm Matching Transformer . . . . . **$1.45 ea.**

NEW VCR Quality MODULATOR
Not a Game Type Modulator

The MPS-1 Kit converts Video/Audio signals to a crystal controlled RF output for TV Channels 3 and 4. The MPS-1 Modulator's adjustable inputs are designed to match all TV Cameras and VCRs and features a voltage regulated power supply, power switch and LED indicator. No Tuning Required. Operates on 117VAC. Ideal for use with our new Debbie CCTV-1 and revised Bambi BEVS-1S.

Assembly Time Approximately 5 Minutes.

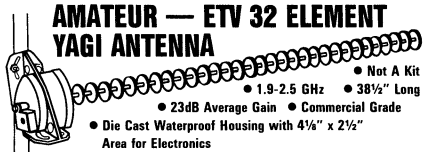
MPS-1 Modulator Kit. $39.95

BE SECURE WITH BAMBI!
Bambi Now Provides Home/Industrial Security With The New ...
Automatic Sequential Scanning BEVS-1S

That's right! In addition to Bambi's regular features listed above, we have added Autoscanning with a controlled 1-10 second Varible Delay for up to six input security cameras. The BEVS-1S allows simultaneous recording on a VCR while observing activity on the monitor. Manual lock-on of any one of six inputs can be accomplished at any time. The BEVS-1S coupled with our new Debbie CCTV-1 listed below makes an excellent security system for your Home or Business.

BEVS-1S Sequential Scanning Electronic Video Switch. . . **$199.95**

AMATEUR — ETV 32 ELEMENT YAGI ANTENNA



- Not A Kit
- 1.9-2.5 GHz
- 38½" Long
- 23dB Average Gain
- Commercial Grade
- Die Cast Waterproof Housing with 4⅛" x 2½" Area for Electronics
- Includes P.C. Probe, F-61 Connector and Mounting Hardware

MAE-2 32 Element YAGI Antenna **$23.95**

SEE PACKAGE OFFER BELOW FOR ANTENNA, DOWN CONVERTER, POWER SUPPLY, & RF AMP.

Kato Sons' Down Converter Kit ★1.9 - 2.5GHz★

Designed for Simple Simon by former Japanese CQ Amateur Magazine's UHF Editor/Engineer. Unit utilizes new ingenious Printed Circuit Probe for maximum gain. Circuit board fits inside MAE-2 antenna housing. Requires mechanical assembly only. All electronics are pre-soldered and pre-tested. Usable up to approximately 15 miles

Model KSDC-KIT 1.9 - 2.5GHz Down Converter Kit **$34.95**

Kato Sons' Regulated Varible DC Power Supply

For use with KSDC-KIT 1.9 - 2.5GHz Down Converter. Completely assembled with Attractive Cabinet, TV/Converter Mode Switch, Frequency Control and LED Indicator.

Model KSPS-1A Assembled Power Supply **$23.95**

Kato Sons' RF Amplifier ★22dB Gain★

High quality 2 stage low noise RF Amplifier for 1.9 to 2.5GHz. Unit requires aproximately 10 minutes assembly. Fits in same housing with down converter. Covers distances of up to 30 miles.

Model KSRF-2 RF Amplifier **$23.95**

SPECIAL PACKAGE OFFER

ORDER ALL THREE ITEMS

MAE-2, KSDC-KIT and KSPS-1A for Only. **$74.95**

Regular price if ordered separately $82.85

— CO-AX CABLES ARE NOT INCLUDED —

SPECIAL PACKAGE OFFER

ORDER ALL FOUR ITEMS

MAE-2, KSDC-KIT, KSPS-1A and KSRF-2 for Only **$94.95**

Regular price if ordered separately $106.80

— CO-AX CABLES ARE NOT INCLUDED —

You Should Have Debbie's™ Quality!

Debbie CCTV-1
CLOSED CIRCUIT TELEVISION CAMERA

Excellent For Use In Home or Business Security Systems, Monitoring Production Lines, Childrens Play Areas, Etc.

Features:

- 2/3" Electrostatic Focusing Vidicon Tube
- EIA 525 Line, 60 Fields Per Sec. Scanning System
- 600 Line at Center Horizontal Resolution
- 1 Footcandle Minimum Illumination
- 10,000 to 1 Automatic Light Control Range
- 1.0Vpp Composite, Negative Sync, 75 Ohm Video Output
- 40dB Signal to Noise Ratio
- Standard "C" Lens Mount
- 110V ±10%, 50-60Hz, 9 Watts

Debbie CCTV-1 Requires C-Mount Lens **$159.95**

16mm, F1.6 Hi-Resolution Lens w/Cap **19.95**

Mounting Bracket Flexible, Locking, 360° Gooseneck for use in ceiling or wall mounting **12.95**

NOTE: When using the Debbie CCTV-1 with Bambi BEVS-1S, an RF Modulator such as our Model MPS-1 is required.

★ **PWD** FOR DETAILS SEE OUR PAST ADS ★ **SPECIAL $109.95**

WRITE FOR OUR CATALOG OF ADDITIONAL CCTV ACCESSORIES

MODEL IC-1 INFRARED CONVERTER

Adapts to any video camera. Reduces energy costs for night viewing by 60%. Video tape in the dark without being detected. Excellent for ● Factory Grounds Security ● Home Surveillance. **Write for Details.**

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*Check orders will be held 30 days before shipping.

THE DRAWING BOARD

Making fixed-output regulators adjustable

ROBERT GROSSBLATT

WE ENDED OUR DISCUSSION OF VOLTAGE regulators last month looking for the answer to an intriguing problem. We were trying to figure out why diode D1 (see Fig. 1) does not conduct even though it seems that current is flowing in the right direction. I'm sure that most of you figured out why D1 doesn't shunt any current when the regulator is operating normally, but let me give you the answer anyway. In normal operation, D1 doesn't conduct because it *can't* conduct. Remember that the regulator's input voltage is always greater than its output voltage. Regulation is like anything else in life—you don't get something for nothing. With the 78*xx* series of regulators the input has to be at least 2 volts higher than the output—if you want everything to work the way it's supposed to. Therefore, the potential at D1's cathode will be at least 2 volts higher than at its anode. Since that reverse-biases the diode, there won't be any current flow.

When things *do* blow up, D1 has to be hefty enough to handle the discharge current from C4, and it has to start working quickly enough to get rid of the current before the regulator is damaged. That's why our choice for D1 has to be a fast-acting silicon diode that is capable of handling the surge current without being destroyed. Depending on the parameters of the circuit, any member of the 1N400*x* family of diodes is a good choice.

Our regulator circuit so far is fine—if all you need is a fixed standard-voltage and not much in the way of current. But suppose some circuit that you're building requires an oddball voltage, and you're sure that the current requirements are going to be rather large. Obviously we have to take our regulator a bit farther.

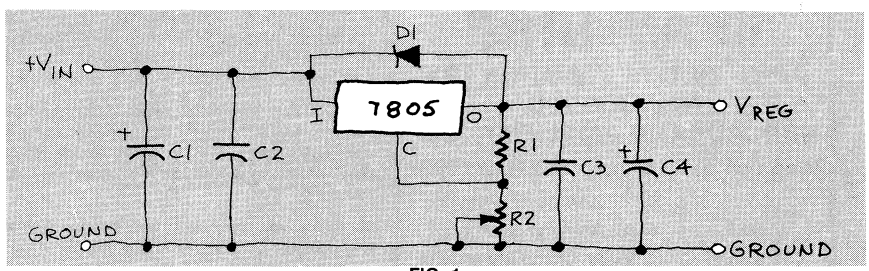

FIG. 1

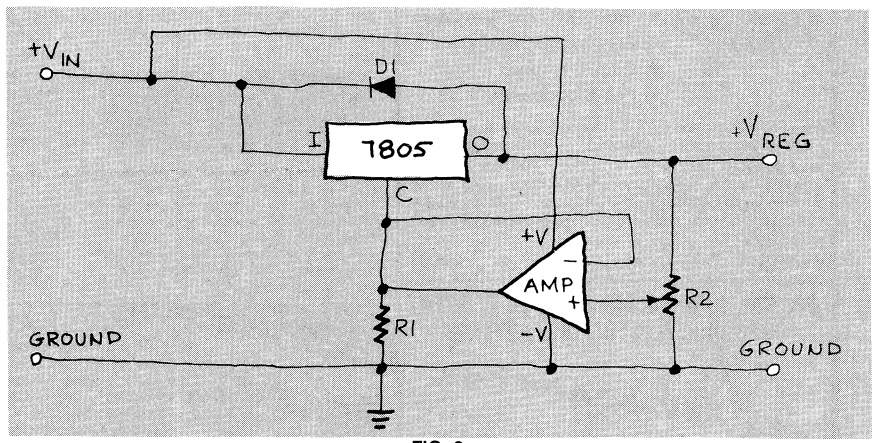

FIG. 2

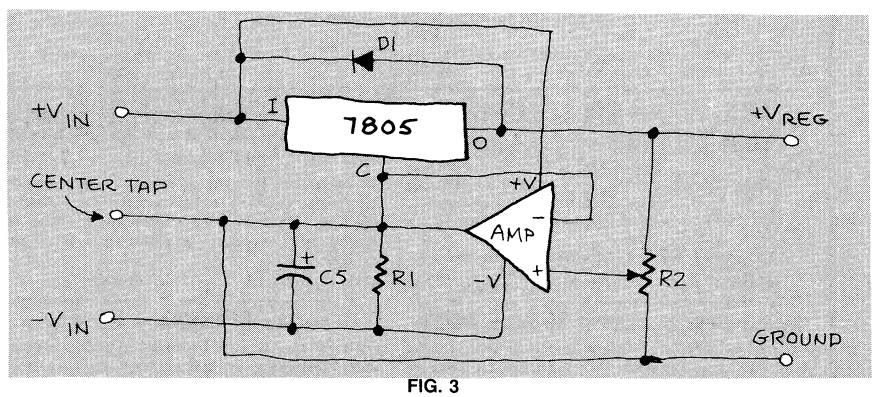

FIG. 3

Raising the output voltage

There are two ways that we can raise the output voltage—let's call them the easy way and the hard way. Figure 1 shows the easy way. Resistors R1 and R2 form a voltage divider across the regulated output-voltage. As we move the wiper of R2 toward ground, we change the ground reference of the regulator and trick it into putting out a higher regulated-voltage. I won't bother you with all the grisly details of the math, but the formula is: $V_{reg} = 5 + (5/(R-1) + I_{sb})R2$ where I_{sb} is the standby current used by the regulator. (For a 7805 with no load at its output, I_{sb} is usually about 8 mA.) Obviously that figure will change as the circuit is put under load. The formula shows us exactly what we're doing—we're adding the voltage generated across the voltage divider to the normal output of the regulator. That approach to an adjustable regulator is okay for small currents, but it leaves a lot to be desired when we're looking for substantial amounts of current and real flexibility. As you can see from the formula, the lowest voltage we can get with that arrangement is the basic voltage of the regulator. Not only that, but we're seriously interfering with the stability of the output voltage.

The reason for the instability is that the regulator can only handle a fixed amount of power. Now, since we all know that power is the product of the voltage and the current, the more voltage we get, the less current we can safely draw from the regulator. As the voltage at the IC's internal pass transistor increases, the internal protection of the IC automatically reduces the short-circuit trip-point. Not only that,

This talking phone TELLS you in clear English what numbers you're dialing.

We'll Try to Describe Everything This Space-Age Phone Does In One Page of Small Type. It Won't Be Easy.

Each key has a separate function. Each one talks to you, if you want it to. What a conversation piece The Everything Phone is!

The Everything Phone is a handsome, contemporary ivory phone with a standard modular plug, ready to go.

It's as though someone said—

"Let's think of *everything* any telephone can do, and combine them into one fantastic instrument."

Someone did say that. This is it.

We call it THE EVERYTHING PHONE because it does everything. It advances the science of phone communications by ten years, even in this age of wild changes and improvements.

For example—

This Phone Actually TALKS To You

The Everything Phone speaks to you in a warm, gentle voice. It never tells you wrong.

Touch the "Voice" switch and when you push a button, the phone tells you the number you've pushed. If you're working in dim light, you won't dial a wrong number, because your friendly phone voice repeats each digit immediately, as you dial it.

If you press the "Prefix" key, the "Clear" key, the Direct Memory Keys, or any of the other special function keys (more about these later), your Phone Voice tells you what you've pushed. If you get tired of company, you can shut off the voice; but it's like having a friend right inside your phone.

A Complete Phone Answering System

This feature takes some explaining. In the bank of keys to the right of the dial pad are three marked M1, M2, and M3. M1 and M2 will tell a caller, when you're out, either when to call back or another number where you can be reached.

What about M3?

M3 makes *any* cassette recorder an answering device. Using the connector (supplied), your recorder can take messages up to the total length of any tape cassette. The Everything Phone turns the recorder on and off automatically when a call comes in.

So—you have your choice of 1) a message, in the phone's own voice, to call back at whatever hour you designate; 2) a message that you're out and can be reached at whatever number you designate; 3) an invitation to leave a message after the tone, with a capacity as long as the cassette—an hour or more.

Memory Keys Galore for Automatic Dialing

At the left of the numeric keypad are ten Direct Memory Keys. The key at the upper left is for MCI, Sprint, or other computer-code dialings. It holds the access number *and* your personal code number.

The other nine let you dial stored numbers, including long distance numbers, by pressing one key. You can inset a tab showing whose number is stored.

But you ain't see nothin' yet!

You actually can store up to *50* numbers of 20 digits each, using a two-number code. Example: if you already have 30 numbers in memory and you want to store 1-305-473-2044, punch in that number, use the "Store" key and "31", and you'll be able to dial that number in the future just by pressing "31".

Quality Speaker-Phone

Of Course The Everything Phone has one-way speaker-phone capability. Of course it's high quality sound.

Just press the "Speaker" button and you have a hands-free phone. A volume control gives you just the right amount of amplification.

Music on Hold; "Mute" Switch

You can put a caller on hold just by pressing the "Hold" key. What a pleasant surprise! Instead of dead sound, the person on hold hears a cheerful melody. (You'll hear it too, so you won't forget he's on hold.)

You have a "Mute" privacy button, and it couldn't be more convenient—it's right in the center of the modern hand-phone. Press that button, and although the other party won't be able to hear you, you'll still be able to hear him or her. Release the button and communications are normal again. (No tell-tale "click" when you press the Mute button.)

Here's a List of Other Built-in Benefits

Your Everything Phone is an electronic butler. It has—

—Automatic redial. Press this key and your phone will redial the last number you called either once (if the phone is off the cradle) or four times (if the phone is in the cradle).

— Pulse/Tone selector switch. In areas with rotary dialing only, slide the switch to "P". In areas with touch-tone, slide it to "T"

— Ringer off switch. You can turn off the pleasant "chirper" (it isn't a bell) when you don't want to be disturbed. A separate ringer l.e.d. light will alert you, if you're interested.

— Access pause key. For Sprint, MCI, and other code numbers, the Pause button gives you the proper gap between the original dialing and the time the system takes to answer with a tone. The Pause has other uses, too, but we just can't list all of them here.

— Secretarial aids. Open a little door and you have a memo pad to jot notes. For the numbers stored in automatic dialing memory, slide out the Directory Card, concealed under the phone unit.

— Battery backup. Two tiny, easily replaceable batteries keep your memory intact. A power failure, even one that lasts for months, won't wipe out what's stored in the memory.

Anything Else?

Probably. We ourselves haven't figured out all the phone assistance The Everything Phone can give you. But we do know this:

No other phone ever made has all the benefits and comforts this one has for you.

CAN YOU BELIEVE IT?
THE EVERYTHING PHONE
IS YOURS FOR JUST
$199.95
two for only **$189.95** each
(+ $4.50 shipping each)

Order your EVERYTHING PHONE by lifting your old-fashioned phone and calling toll-free:

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Ask for Operator 551.
(In California: 1-800-852-7777)
Have your VISA or MasterCard handy.
Phones are manned seven days a week, 24 hours a day.

We Absolutely Guarantee!

The Everything Phone is a lot of fun, and it's the darnedest electronic instrument you ever owned. But if at any time during the first full month you own it you decide not to keep it, send it back and we'll refund every cent you paid.

Send check or money order, or charge card information (**$199.95** + $4.50 shipping—Total, **$204.45**) to New Horizons, or call the toll-free number above.

The Everything Phone
is another electronic marvel from

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but if you use that circuit and the current drawn from it comes close to the trip point, R1 and R2 will start to get warm and change value. And, changing those values will also change the output voltage. Fortunately the IC is protected and thermal runaway isn't possible, as it is with transistors. Even so, it's annoying, to say the least, to have your power supply drop out every time you put a moderate demand on it.

A better, but slightly more complicated, way to make an adjustable supply from a fixed regulator is shown in Fig. 2. I've left out the capacitors to make the drawing clearer and cleaner. If you compare this circuit with the one shown in Fig. 1, you'll see that an op-amp has replaced the potentiometer. Since some of the newer op-amps have input impedances as high as a trillion ohms, it's pretty safe to say that the output of the regulator won't be loaded down as it was in the first circuit. The op-amp is set up as a voltage follower, which means that it's nothing more than a buffer—a noninverting amplifier that's used to isolate one part of a circuit from another.

As we move the wiper of R2 away from ground, an increasingly greater voltage is present at the ground terminal of the regulator. That raises its ground reference and tricks it into putting out a higher voltage. The drawback is that the minimum output voltage is still going to be the standard output of the regulator, in this case five volts, plus the voltage drop across R1, which is about two volts. On the other hand, we can get the regulator to put out as much as 20 volts without worrying about limiting the current-handling capability of the IC, or degrading the voltage regulation when the numbers start to get large. This adjustment range of 15 volts or so is just about the most you can hope to safely get out of a fixed regulator like those in the 78*xx* series. You can move the entire output range slightly by changing the value of R1, but trying to extend the range too far will cause you to run the risk of doing severe damage to the IC. After all, remember that it *was* designed to be a fixed regulator.

Lower output voltages

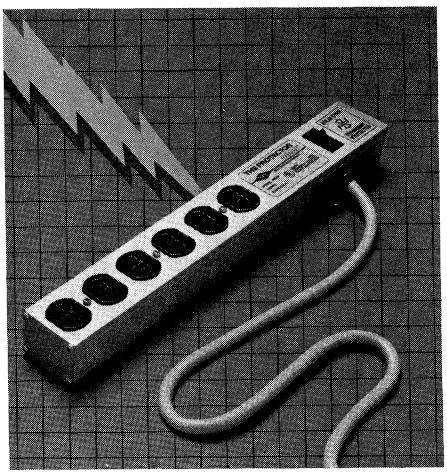
There is a way to change the range of the (fixed) adjustable regulator so that we can drop its output voltage much closer to ground. The way to do that is to allow the op-amp to swing its output below ground. Figure 3 shows how that can be done. By using a center-tapped transformer we can reference the ground terminal of the regulator and the $-V$ input of the op-amp to a level below system ground. Then, the regulator will reference its output voltage to a point below ground. We have to be careful when we set that sort of thing up however, because the regulator's internal pass transistor was designed to source current, not to sink it. If the output level of the regulator gets below ground we're going to have the same problem we had last month and the same thing will result—one french-fried regulator.

Another alternative is to build a small circuit that generates a true negative supply from the positive system-voltage. We don't need a lot of current since the op-amp draws next to nothing and the regulator is only using the negative voltage as a reference point.

You can always use a different regulator, such as the LM317, which was designed to go as low as 1.25 volts and up to more than 35 volts. Your regulator-circuit design will be easier, but you won't learn anything. Besides, there's a certain amount of perverse pleasure that comes from making an IC do something it wasn't expected to do in the first place.

One other thing you should remember is that there's always at least a two-volt drop across the regulator. If you're planning on designing a power supply that can put out 20 volts, make sure that you have at least 22 volts available at the input to the regulator. The same goes for the amount of current you can draw—you can't get out of the regulator what the transformer and rectifier can't put in.

When we continue next month we'll increase the current-handling capability of our circuit and add additional circuitry to make it short-circuit proof. **R-E**



THE PROTECTOR 6000™

TOTAL PROTECTION FOR YOUR SENSITIVE ELECTRONIC EQUIPMENT.

Something that you can't even see may be slowly but surely killing your expensive electronic equipment. It's transient voltage, and it can be fatal to computers, medical equipment, electronic games, videotape recorders, electronic test equipment, electronic cash registers — almost any of today's sophisticated solid state equipment.

THE TRANSIENT VOLTAGE PROBLEM.

Most of this modern electronic equipment uses LSI and MOS semiconductor devices which are extremely sensitive to voltage transient surges or "glitches." In fact, a large percentage of equipment failures can be directly linked to the damaging effects of over-voltage line transients to unprotected, highly fragile components.

THE PROTECTOR 6000™ SOLUTION.

Not to be confused with other transient voltage protection units available today, THE PROTECTOR 6000 uses state-of-the-art solid state components and exclusive circuitry to provide you with *complete and total protection from transient voltage surges* of up to 6,000 volts. THE PROTECTOR 6000 uses silicon PN junction devices — proven to provide the fastest response to surges! They have a statistical life expectancy of over 20 years. THE PROTECTOR 6000 has a maximum clamping voltage of only 335 volts, well below the voltage rating of other transient protection devices which commonly use much less effective MOV's or gas discharge tubes. It also provides full protection from electro-magnetic and radio frequency interference. The unit operates in both common and differential modes, and is outfitted with a circuit breaker to guard against severe current overloads over 15 amps.

Why take chances with your expensive electronic equipment? For full details contact your local NTE distributor or write:

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THE PEOPLE WHO BRING YOU THE TCG LINE OF SEMICONDUCTORS.
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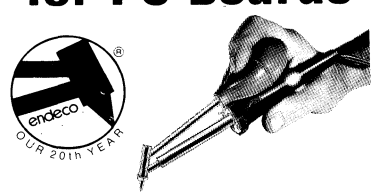
Vital protection for PC Boards



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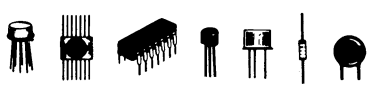
These PC components replaced fast with Endeco desoldering or soldering tools.



Endeco professional features include safety light that denotes *high, low* and *off* on switch models, SS construction for long life, light weight and balance for easy use.

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Phone: (317) 251-1231

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No wonder they call it the SUPERFONE!

At Last—a Cordless Phone with TWICE the Range, Sound Fidelity to Rival Phones with Cords, and a Privacy Code System—All This in a Phone Less Than an Inch Thick!

The Super Fone is less than 1" thick. The base unit has a built-in speaker phone, a fully independent intercom and is 110 volt-220 volt switchable.

Until now, cordless phones have given you wonderful convenience. But they've had two problems:

1. The range is limited to 600 to 700 feet.
2. Some of them sound as though you're talking inside a barrel.

As cordless phones have become enormously popular, another problem has arisen: two people, living near each other, can have the same channel. Not only is there line confusion, but someone else can literally make a long distance call on your phone.

No more. Never again.

Range: 1500 Feet OR MORE!

The SuperFone 650 uses state-of-the-art electronics to bring you **the ultimate cordless phone.** Sound quality is superb — and it stays superb, 1500 feet or more from the base station. That's **more than twice the distance** of standard cordless phones.

Only SuperFone 650 has a secret code system to prevent interference and false operation of the phone. You choose from 512 possible "code" combinations. Both the base unit and the phone are **locked** onto that code, which you can change when you want to.

No other phone can interfere. No other unit can share the signal. No one else can hear or speak on your carrier-wave.

Enormous Range

We say the SuperFone 650 has a range of 1500 feet.

Notice we didn't say "up to" or "as far as" 1500 feet. There's no hedging, because this seems to be the **minimum,** not the maximum range.

Users report 1800 and 2000 feet. That's nearly half a mile. SuperFone 650 is a radiophone, not a toy, and that's why its signal doesn't break up or start hissing or crackling when you get half a block away.

You can tell when you heft it. It's a Little Giant. You can feel the power inside. What a marvel of electronic engineering it is! And it's tough, too. It fits into your shirt pocket, and you can bounce it around all day without damaging it.

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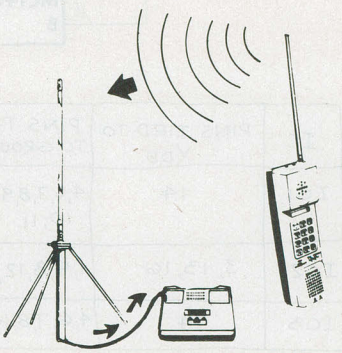

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NEW IDEAS

Frequency-boundary detector

I'M SURE THAT EVERY ELECTRONICS EXperimenter or hobbyist, at one time or another, has needed a device that would indicate whether or not a signal was within a certain frequency range—I know I did when I was working with a switch-mode power supply. I got what I needed by building the frequency-boundary detector whose circuit is shown in Fig. 1. (The IC's supply and ground connections are shown in Fig. 2.)

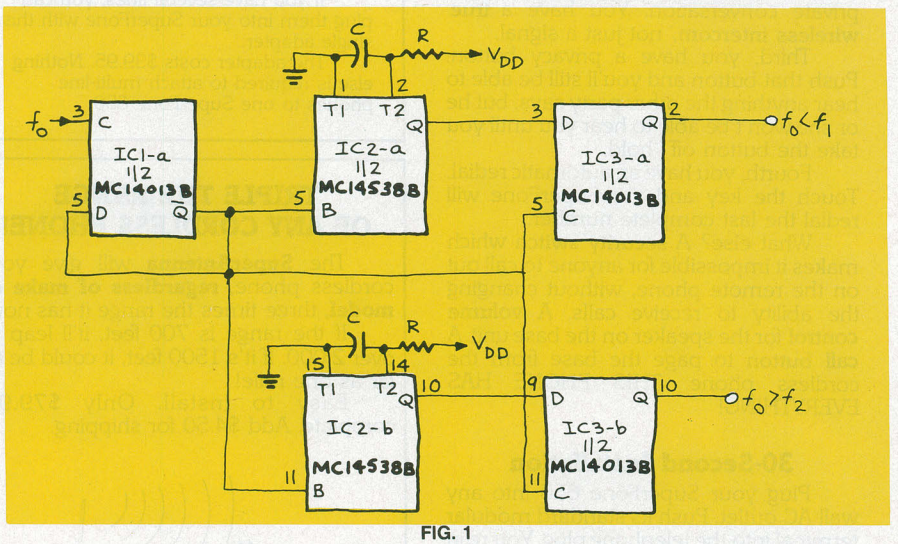

FIG. 1

IC	PINS TIED TO V_{DD}	PINS TIED TO GROUND
IC1	14	4,6,7,8,9, 10,11
IC2	3, 13, 16	1,4,8,12,15
IC3	14	4,6,7,8,10

FIG. 2

The circuit can be used (with LED's or other indicators) to tell you whether or not an input signal is within a certain frequency range. Because you may be hard-pressed to come up with applications for the circuit, I should point out that voltage-to-frequency converters can be used to make the number of applications almost limitless.

The device itself is rather easy to build. It consists of three IC's—a dual monostable multivibrator and two dual D-type flip flops. The signal whose frequency is in question is fed to the clock input of one of the flip-flops. The $\overline{Q}$ output of that flip-flop (IC1-a) is cross-coupled to its data input so that it acts like a divide-by-two counter. (See the timing diagram in Fig. 3.) The trailing edge of the $\overline{Q}$ output is used to trigger the one-shots formed by IC2.

The upper- and lower-frequency boundaries are determined by the two sections of IC2—the dual precision monostable multivibrator—and their external

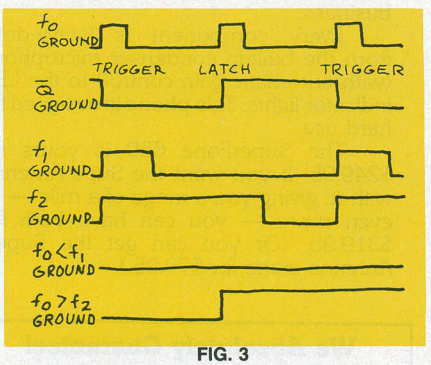

FIG. 3

resistor-capacitor networks. The upper-frequency boundary ($f1$) is set by the output of IC2-a, and the lower-frequency boundary ($f2$) is set by the output of IC2-b. The relationship that describes the periods of the outputs of IC2 is: $T = \frac{1}{2}RC$, where T is measured in seconds, R in ohms, and C in farads. However, because IC1-a is used as a divide-by-two counter, the formula used to determine the period of the upper- and lower-frequency boundaries becomes: $T = RC$.

The frequency of the input to the circuit can be anywhere from DC to 100 kHz. However, you can use the "extra" half of IC1 as another divide-by-two counter and increase the circuit's range to 200 kHz. Then the period of the outputs of IC2 would be represented by: $T = 2RC$.

The states of the outputs of IC2, which determine the upper- and lower-frequency boundaries, are latched by IC3-a and IC3-b respectively. As shown in the timing diagram of Fig. 3, the output of IC3-a (which is clocked by the output of IC1-a) will be high only when the input frequency is less than that of the output of IC2-a ($f1$). The output of IC3-b will be high only when the frequency of the input is greater than that of the output of IC2-b ($f2$). You can use appropriate logic gates to give an "in-bounds" or an "out-of-bounds" indication.—*Jim N. Kitchen*

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

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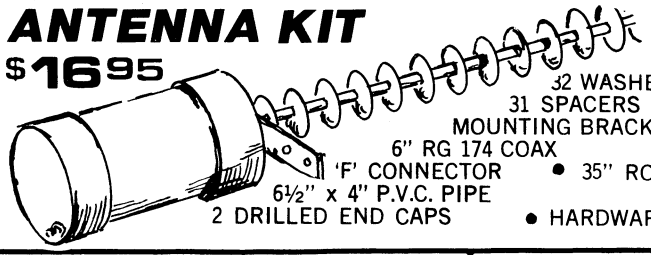

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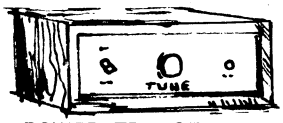

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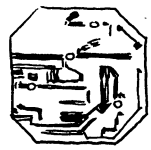

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SERVICE CLINIC

Countdown circuits

JACK DARR, SERVICE EDITOR

IN THE EARLY DAYS OF THE SPACE PROGRAM we all became familiar with the term "countdown." In late-model TV sets, however, that term has taken on a whole new meaning—there is refers to a type of timing circuit. Frankly, I don't have a whole lot of data on those circuits, but I've run into them on several occasions. So, this seems as good a time as any to take a look at how they work, and to get some idea of what to check if you come across any problems with them.

Sets with countdown circuits have no vertical or horizontal oscillators; they have no hold controls, either. To generate the horizontal sweep, they feed the composite-sync signal into an IC. (A simplified block diagram of one is shown in Fig. 1.) There, the vertical sync is stripped off and the horizontal sync is fed to an amplifier stage; that stage shapes the signal and boosts it so that it is capable of driving the horizontal-output stage.

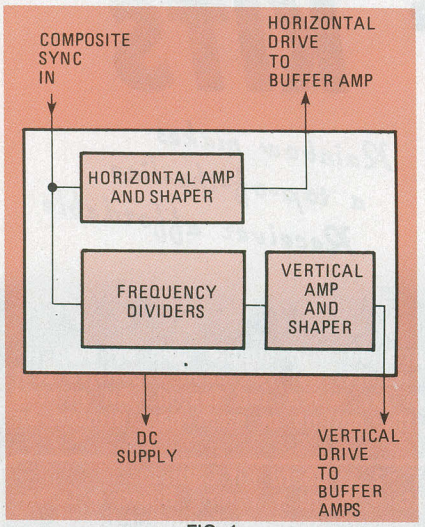

FIG. 1

Since the horizontal-sync frequency is a multiple of the vertical-sync frequency, the vertical sync can be derived from the horizontal sync. That is done by first feeding the horizontal sync to a series of frequency dividers. Incidentally, that's where those IC's get their name. The dividers are actually counters; they "count down" the number of pulses they receive and when a predetermined count is reached, they put out a single pulse. Those counters divide down the horizontal-sync frequency to the vertical-sync frequency. Once the dividers have done their job, the resulting signal is fed to the vertical amplifiers and out to the output stages.

There is a distinct benefit to that method, and a minor drawback that will be mentioned later. The benefit is that the horizontal and vertical sweeps are perfectly synchronized. They have to be, since they're derived from the same source. The same technique has been used for some time in color oscillators. Instead of there being a separate 3.58-MHz oscillator, the color-burst signal from the TV station is passed through a crystal, which is used as a very sharp filter, and then amplified. The amplification makes the burst "ring" longer; it's then clipped, limited, and comes out as a nice smooth 3.58-MHz signal. Again, it is always in phase with burst, since it *is* the burst.

Troubleshooting countdown circuits

Testing countdown circuits is fairly simple. The first step is to scope the input sync-signal—it has to be there or nothing will work. In one set I worked on, that signal was very noisy and was low in amplitude. The problem was traced to a discrete transistor sync-separator, which was very leaky. With a good input-sync, check the vertical and horizontal outputs. If either of those is missing, check all the components in the appropriate circuit. Also, check all the DC voltages to the IC, the DC supply itself, and all the voltages coming from the IC. If any are off, check the discrete circuitry outside the IC. If everything around the IC checks out OK, then the problem must lie with the IC. Never assume that the IC is bad until you've checked everything else!

But...

Now we come to the drawback. Sets using countdown circuits are particularly susceptible to co-channel interference, especially in fringe-reception areas. In fact, even cable reception can be affected. When co-channel interference occurs, you're actually seeing signals from two stations at once. The syncs mix and the result is the stock symptom—closely-spaced horizontal lines, in pairs, all up and down the raster. Also, the vertical-blanking bar will drop down a couple of inches, then settle down and jitter. You may even see the horizontal-blanking bar floating across the screen at times.

What's happening is that the interference is being caused by a sync signal, even though you may not be able to make out its associated picture; remember, the sync is the strongest part of any TV signal. Because of that co-channel interference, the IC is seeing two signals; one of them you want, but not the other. There will always be a phase difference between them; since the interfering signal must travel much farther it is delayed by a few microseconds. The result is that the IC doesn't know which signal to lock on, so it jumps back and forth; that's the jitter. Oddly enough, I've never seen the horizontal sync affected. What's the cure? None! You just have to wait until the conditions that are permitting the interfering signal to reach the set change—that will usually take 30 minutes or less, although sometimes the interference can go on for several hours.

So, like all other IC's, and other components too for that matter, countdown-circuit IC's aren't hard to test and service. Just ask yourself: "What is the part supposed to do, and is it doing it?." Check the signal-in, signal-out, DC voltages, and all the external components, and you'll find the problem. If you trace it to the IC itself, perform the standard tests on that component. Follow that procedure and you'll find the cause of the trouble in short order. **R-E**

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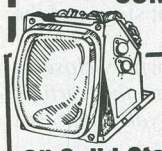

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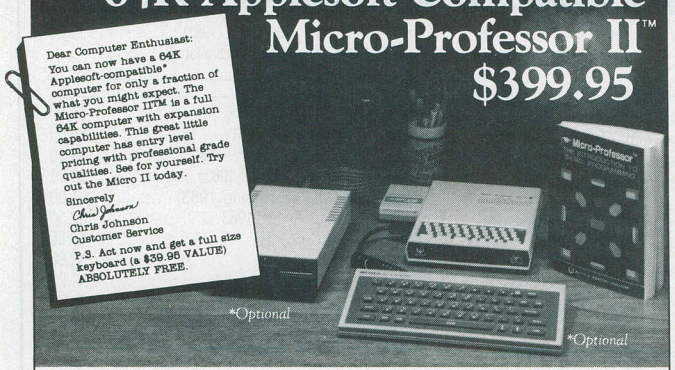

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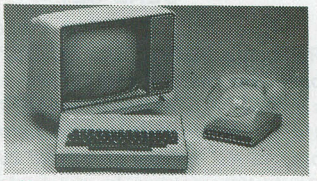

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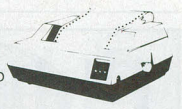

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that transistor has a socket, it might be dirty. When taking the old one out and replacing it, something managed to make contact again. I, too, expect the problem to re-occur.

DEAD SET

This RAC CTC-684A looked dead. Replacing SCR101 and SCR102 brought back the raster—and a loud horizontal squeal. I replaced MAH001A and MAL001B, but that was no help. I found only 15 KV instead of normal 28—31 KV. Could the problem be the tripler?—E.L., New Orleans, LA

That's barely possible. I've seen lots of tripler problems, but not that one. The squeal, etc. are signs that the horizontal oscillator is off frequency. That can often be due to an open filter capacitor allowing a feedback loop to set up. Check the hot terminals of all the filter capacitors on a scope, and check the B – line feeding the horizontal-oscillator module.

(Feedback: Right! Filter capacitor C104, on the 161-volt line to the horizontal module was open. Thanks!)

WORMS ON RASTER

A while back, I wrote you about a Quasar WP5006KW that had funny "worms" down the right side of the raster. You told me to do this and that (and I did), and also to try out a new 6LX6 horizontal-output tube. That helped, but didn't solve the problem completely. I wrapped aluminum foil around the bulb of the new tube, and that solved the problem—for about an hour. Then, SNAP! The set went dead, and there was a little hole in my new 6LX68.

Looking back at your letter, I see that you told me not to let the holding ring get too close to the tube or it might arc through the glass. I should have listened!—H.M., Largo, FL

Guess how I found out about that problem. The same way you did!

BURNING RESISTOR

I asked you about a problem in a Sharp 2K39—the 470-ohm resistor, R207, burned up. You hit it on the head; the output transformer, T302, was breaking down and shorting to ground. Thanks very much.—B.M., Cooper Mills, ME

VERTICAL COLLAPSE

The picture's OK on this Truetone SCJ4719A-77 for about 15 minutes, then it collapses to a band about three inches high. If I snap the set off and on, the picture comes back again for about another 15 minutes. I've changed the vertical-oscillator-drive IC and checked voltages, but, so far, with no success.—C.M.H., Raleigh, NC

That is a typical result of an intermittent electrolytic capacitor. Try replacing C508, the coupling capacitor between the vertical output stage and the yoke.

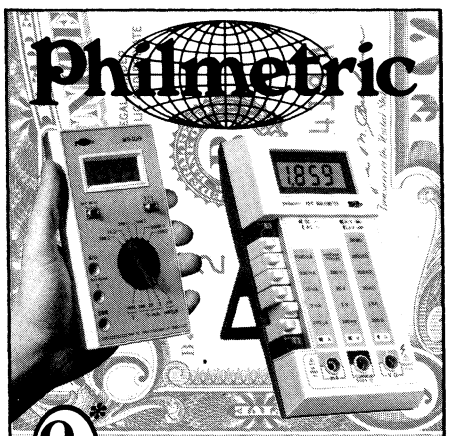
(Feedback: You were awfully close! It was capacitor C509 (from the vertical output to the other end of yoke) that was the bad one. Thanks!

TELL ME WHERE YOU ARE

I got a letter recently that reminded me of something I've been meaning to bring up for some time now. When you write to me with questions, please don't forget to include your address. There are few things more frustrating than having an answer and nowhere to send it. Please be sure that you've written your address somewhere, OK?

PROBLEMS, PROBLEMS

This Sears 564.41701502 came in with an open focus dropper-resistor in the high-voltage rectifier assembly. It also had no vertical hold and the vertical sweep was running at 120 Hz with foldover. First thing I did was replace the high voltage rectifier. Then, using a scope, I checked the emitter of Q451 and found 120 Hz, as well as some glitches caused by a bad shaping-diode, D452. Changing the diode got rid of the glitches, but not the 120 Hz. I replaced Q451 with a substitute and that helped, but not all the



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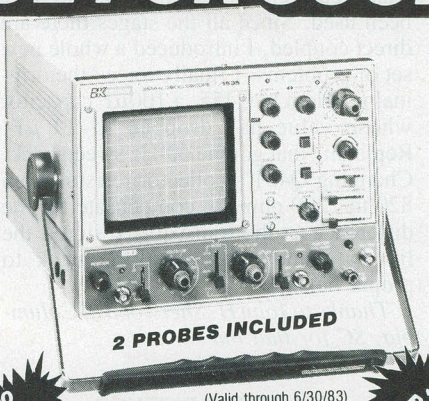

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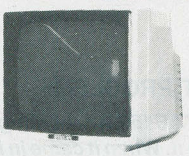

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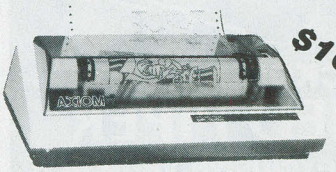

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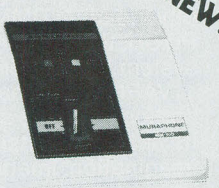

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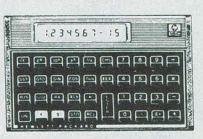

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way. It turns out that a manufacturer's exact-replacement transistor should have been used. Since all the stages there are direct coupled, I introduced a whole new set of problems. I finally traced the original problem to C455, a 100μF capacitor whose value had dropped to 20 μF. Replacing that got the 60-Hz sweep back. Changing Q451's collector resistor from 820 to 2200 ohms to compensate for the difference in the transistors restored the linearity and got everything back to proper balance.

Thanks to John H. Sherwood of Columbia, SC for that one.

MAGENTA PICTURE

The screen on this RCA CTC68A is magenta with retrace lines. After 5 minutes, the picture color becomes good. It will stay that way for anywhere from 5 minutes to the entire day, but the magenta color will eventually return. Turning the set off and on will restore the proper color, at least for a while. What could be causing that?

Incidentally, the Sams schematic for this model shows +5.49 volts on the green screen-grid of the picture tube. That can't be right, can it?—D.B., Park Ridge, IL

Your magenta screen is being caused by a loss of green, leaving only red and blue. It sounds as though you have a problem in the green video-output. Try swapping the green MAD001A video module for either the red or the blue one. If the problem shifts to the red or the blue, you've found the source of the trouble. Replace or, if you wish, repair the module. If you choose to repair it, a good bet is the transistor; either it or one of the other components is intermittent.

As to your second question—you're right. I don't know how that decimal point got in there. The correct reading should be 549 volts.

SOLDER-JOINT PROBLEMS

I've got this GE 17AC1602W working, but I'm not happy with it. When it came in it had a shutdown problem. That was taken care of by running a jumper from Q980, the shutdown SCR, to C555. Later on, the set developed a peculiar dark blob, like an octopus, that floated slowly upwards across the picture. I traced that problem to a cold-solder joint at R980; that was causing the resistor to overheat. I had previously fixed several other cold-solder joints, but that was one I had missed. I suspect that there are still others, and can only hope that they show up before I take it home.—A.B., Cambridge, MA

I've had many letters like yours, and they keep coming. All I can tell you is that I suspect that you're right and that you keep looking. One suggestion is to try cooling spray, and jarring the board, to make the less obvious cold-solder joints show up. **R-E**

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NEW BOOKS

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BASIC ELECTRONICS THEORY with projects and experiments, by Delton T. Horn; TAB Books, Inc., Blue Ridge Summit, PA 17214; 531 pp. including index; 5 × 8½ inches; softcover; $11.95.

This is a practical, all-inclusive handbook ranging from atoms and their electrons to the newest calculators and computers. It is designed both as an introductory text (with experiments) of basic electronics theory, and as a convenient reference manual of fundamental concepts. The material has been divided into convenient chapter topics so that almost any piece of needed information can be located quickly.

The author notes that it is impossible for any single volume on electronics to be totally complete, because electronics is a constantly growing field. Certain material has been eliminated here, either because it is likely to become obsolete soon, or because its nature is so specialized that the applications are extremely limited. However, this book should provide the reader all of the information needed for a basic understanding of almost any electronic device or circuit. More important, it will provide the reader with the necessary background for understanding articles in the more technical electronics journals, and for reading schematics.

The reader is urged to perform the experiments presented, because nothing enhances the learning process better than "hands-on" experience and the experiments were chosen to provide practical demonstrations of the principles discussed in the text.

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PET/CBM AND THE IEEE 488 BUS (GPIB), 2nd edition, by Eugene Fisher & C.W. Jensen; Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710. 250 pp., 6¼ × 9¼ inches; softcover; $15.99.

Bench-top engineers, scientists, and micro enthusiasts can now take advantage of a low-cost GPIB (*G*eneral *P*urpose *I*nterface *B*us) system. With the use of an IEEE 488 bus, Commodore PET and CBM computers can control up to 15 digital instruments. In this newly-revised book, the capabilities of each PET or CBM model are described, along with the history and functions of the IEEE bus. Users can learn how PET and CBM computers can be connected to a variety of instruments via the bus. Each type of transaction is explained with its associated PET BASIC statement, and is illustrated with a detailed timing diagram of the actual signals placed on various bus lines and detailed programming charts.

There is also an expanded appendix. Approximately 200 manufacturers are listed, along with hundreds of their products that operate on the IEEE 488 bus. IEEE standard definitions, the ASCII definitions, and the PET/CBM ASCII and ASCII-IEEE-488 hex codes are also listed.

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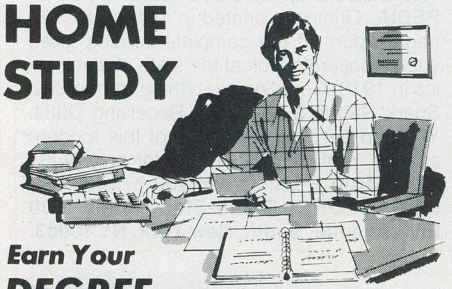

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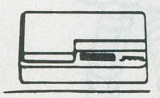

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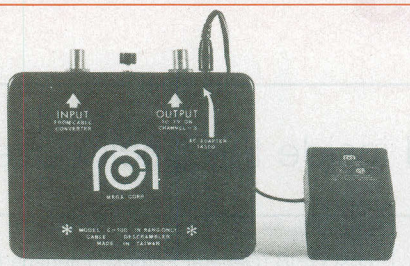

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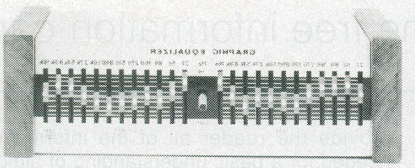

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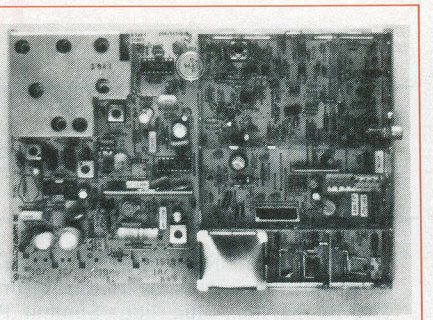

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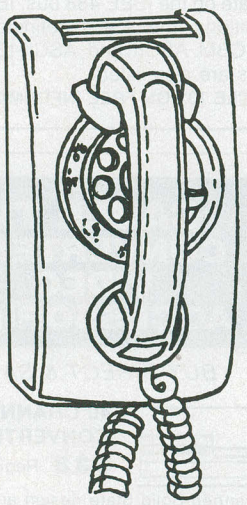

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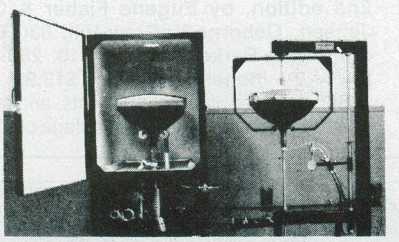

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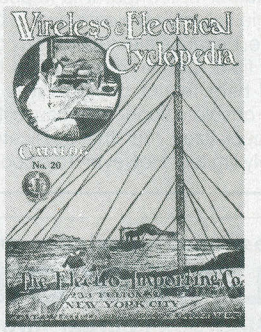

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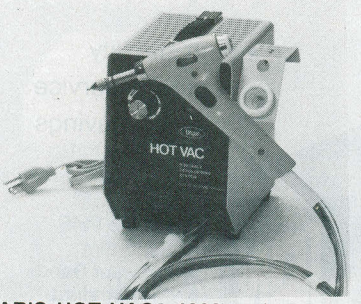

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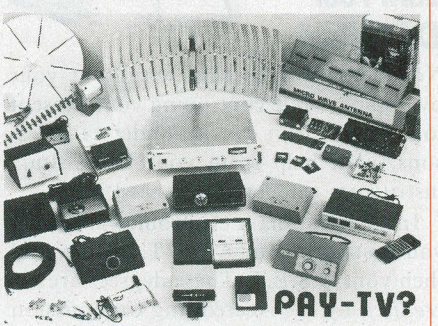

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COMMUNICATIONS CORNER

Electronic mail via satellite

HERB FRIEDMAN, COMMUNICATIONS EDITOR

NEITHER RAIN, SLEET, SNOW, NOR KILLER satellite.....No, they haven't replaced that old motto—yet! But as the postal service moves into the era of modern communications, killer satellites might prove to be more of a threat than the gloom of night.

Most of us tend to believe that innovations in mail delivery ended with the Pony Express. (In fact, the Pony Express was faster in many cases than today's mail service.) That's because most modern "improvements" in the mail service do nothing more than get a pair of hands to do more work. That's not to say that there have not been any improvements in automation, but letters still arrive by hand, are often moved by hand, and are delivered by hand.

But now there's a new postal service, called INTELPOST, that moves a letter thousands of miles in a matter of minutes by taking advantage of the very latest in computer and satellite technologies. INTELPOST processes your letter or other document through optical scanners, computers, and a full-time channel on Comsat's INTELSAT IV-A satellite. Almost instantly, your documents can be flashed across the ocean. The actual processing of a document or letter up to 8½ × 14 inches takes only 1 minute and it costs you only $5 per page.

In many cases you might find that you can send a letter overseas and receive a response in less time than it normally takes a letter to travel from your local mailbox to your local post office. Now that is definately an improvement in the postal service—and I would not hesitate calling INTELPOST a true innovation.

How it's done

Figure 1 shows the links in the chain. An INTELPOST computerized service center in the U.S., an earth station, the satellite, and an earth station and INTELPOST-equipped service center on the other side of the world.

All you have to do to take advantage of the service is to carry or deliver your document to an INTELPOST service center where it is placed on an optical scanner. In a matter of seconds the scanner converts a full page of ordinary typewritten text into electrical signals that are stored in a computer until an overseas circuit and service center are cleared for reception. The computer then sends an encoded representation of your document to an earth station in Virginia, which transmits your document to the satellite, which relays it to the receiving station. The received signal is forwarded to a service-center computer, which decodes the signal and passes the plain text output to a facsimile printer where a black-and-white reproduction of the original document is created. The printout itself can often be sharper and of higher contrast than the original.

You can even specify the time you want the letter delivered at the other end in, say, London. Your business associates, friends, or family, can go to their local London INTELPOST post office and pick up a letter you might have mailed as little as an hour earlier; then almost instantly they can send a reply back to you. If they're not in that much of a hurry, they can have your letter delivered with the regular or special delivery mail.

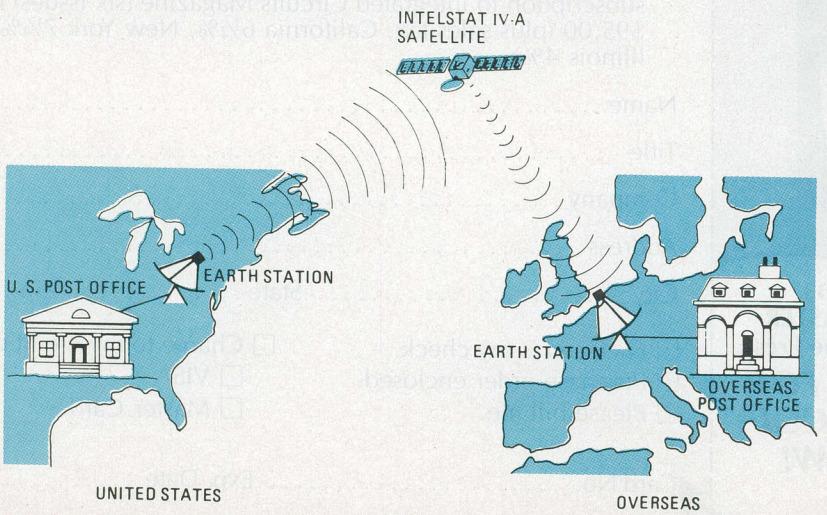

FIG. 1

As you might expect, considerable effort goes into security. First, the computer at the service center encodes the transmission using the highest encoding level developed by the Dept. of Defense. (I assume and hope that it means no one is going to crack the code.) Second, only one employee handles your exposed document at each end: the one who puts it on the scanner and the one who takes it off the facsimile printer.

Getting the document to the post office is a minor problem if you're not located in the metropolitan New York or Washington, D.C. areas. You can use Express Mail service to the nearest INTELPOST station, or you can send it there by regular mail. If you mail in your documents, they are returned to you at no charge after transmission.

Presently, the direct satellite path from the U.S. is to Great Britain, the Netherlands, Germany, and Argentina. INTELPOST also handles transmissions to Canada by wire. A Pacific satellite will soon open the service to Australia.

From conversations with our postal-service people, the limitation of the service appears to be the availability of dedicated satellite channels. It is expected that much of the overseas mail will be handled by the computer-satellite link when more channels become available. Certainly, the $5 cost is competitive—particularly for business documents—and the speed and the reliability of the copy is something phenomenal.

Now imagine the next step in this process. Instead of delivering your document to the post office facility, you simply dial the INTELPOST computer on your phone and transmit your document to the computer from your own word-processor. The signal then goes overseas by satellite where the receiving computer dials the addressee's phone and sends your document into his or her word processor or computer. And the bill goes on your VISA or MasterCard. Now *that's* real electronic mail. **R-E**

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TOP TEN GAMES OF '83

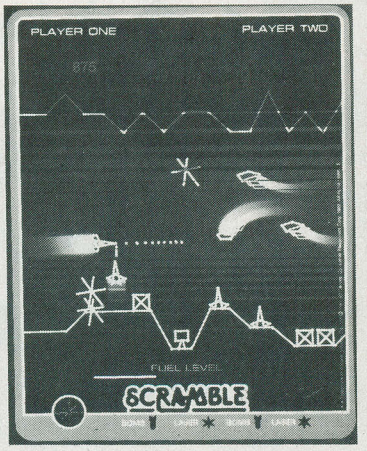
continued from page 76

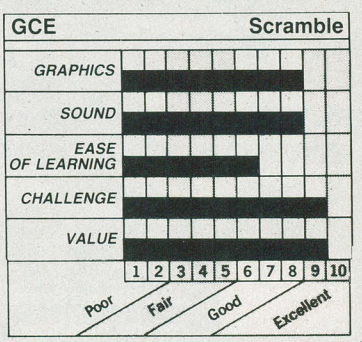
one row of logs, a lady frog appears from time to time. If your frog can get on the same section of log, she'll hop on his back, thus giving him more points when he reaches one of the home bays. Also, turtles occasionally dive into the water; your frog can't be on their backs when they go down. In some home bays, a bonus fly appears at random. The frog needs to be directed into that bay to collect those points.

At higher skill levels, as in the arcade version, deadly snakes appear on the center river bank and on logs. Traffic also increases in speed and density. The entire game is played against time, with a 30-second time band per frog displayed at the screen bottom reminding the player of that fact.

It is rare for any home version of an arcade original—regardless of resolution and memory size—to capture the nuances of a quarter-eating game. But in this case, we have not only a true-to-arcade game available on a very popular system, but the game itself is one that is likely to be enjoyed by more than just the hard-core game players. Perhaps that's why *Frogger* has remained so popular in the arcades for such a long time, and continues so at home.

GCE's Scramble For Vectrex





One of the year's most addictive games is playable only on the self-contained vector scanning *Vectrex* console from General Consumer Electronics (233 Wilshire Blvd., Suite 220, Santa Monica, CA 90401). *Scramble*, as any video-arcade goer knows, is a horizontally scrolling game that puts your space fighter in several different scenes, each with a peculiar kind of hazard to overcome.

The trick with *Scramble* is learning how to use the acceleration and braking characteristics of the joystick.

While you're busy figuring out how to control your spacecraft, you also have to maintain control over your weapons, which fire straight ahead, and your bombs, which drop as you pass. You also need to keep a third eye on your fuel level. Some ground targets are fuel tanks that, if destroyed, add fuel to your tank. At the higher skill levels, you have an incredibly long way to go without any chance of refueling. And when you run out of gas or hit a wall, the crack-up in the *Vectrex's* inimitable fashion is painfully realistic.

Like any other well-designed game, the *Scramble* taunts you to come back for more. If you are already committed to the *Vectrex* console, that game is the first you should buy for your collection. And if you're still looking at videogames, be sure to test the *Vectrex* with this cartridge if at all possible. **R-E**

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An automatic brightness controller

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

A UNIQUE DEVICE THAT IS QUITE VERsatile in applications that require the automatic adjustment of the brightness of a display in relation to variations in ambient light, is the new Optron OPL 100 automatic brightness controller. That device from TRW Optron can operate from a supply voltage of from 4.5 to 24 volts DC, and can source 50 mA or sink 20 mA to control the brightness of various types of displays from 0 to 100 percent. The display types that it can control include vacuum fluorescent, incandescent, and LED's. The OPL 100 can be used to control TV screens, instrument displays in aircraft and automobiles, industrial light levels, and outdoor lighting for signs and security purposes. The device can also be used to keep the indoor light level constant, regardless of variations in light coming in from outdoors.

Pulse-width modulation is the key to the controller's operation. The duty cycle of the output is proportional to the ambient light level and is the basis for controlling external displays. Ambient light levels are detected by a 2500 square mil (0.0025 square inch) photodiode that is built into the device.

Figure 1 shows a block diagram of the OPL 100, an 8-pin IC. Figure 2 shows how it's used to control the brightness of LED's, 7-segment numeric displays, and vacuum-fluorescent displays. In each case, the displays are driven by the pulse-width-modulated output from pin 7. Potentiometer R1 is the external adjustment for light sensitivity level. The resistance needed depends on the ambient light level, and on the display brightness desired—it ranges between 25K and 200K.

In Fig. 2-a, the device controls the brightness of a standard LED. With a 12-volt DC supply, the controller furnishes a maximum of 32 mA to the LED. Figure 2-b shows how the controller is connected to a numeric display through a BCD-to-7-segment latch/decoder/driver like the CD4511. Several drivers can be used and multiplexed by connecting the strobe or enable line of each driver to pin 4 of the controller through suitable logic circuitry.

In Fig. 2-c, we see how to connect the OPL 100 to a vacuum-fluorescent display device to control display brightness between 0% and 100% intensity. Resistor R2 (shown as dashed lines) is needed in this application to prevent the display from going completely off when the sensor is in total darkness. The OPL 100 should be mounted so that its photodiode sensor receives light from the direction from which the display will be viewed. Potentiometer R1 should be adjusted for a satisfactory display brightness in normal ambient light. Now, the controller will detect changes in ambient light and adjust the brightness of the display. Because of that, the display brightness will appear to remain constant.

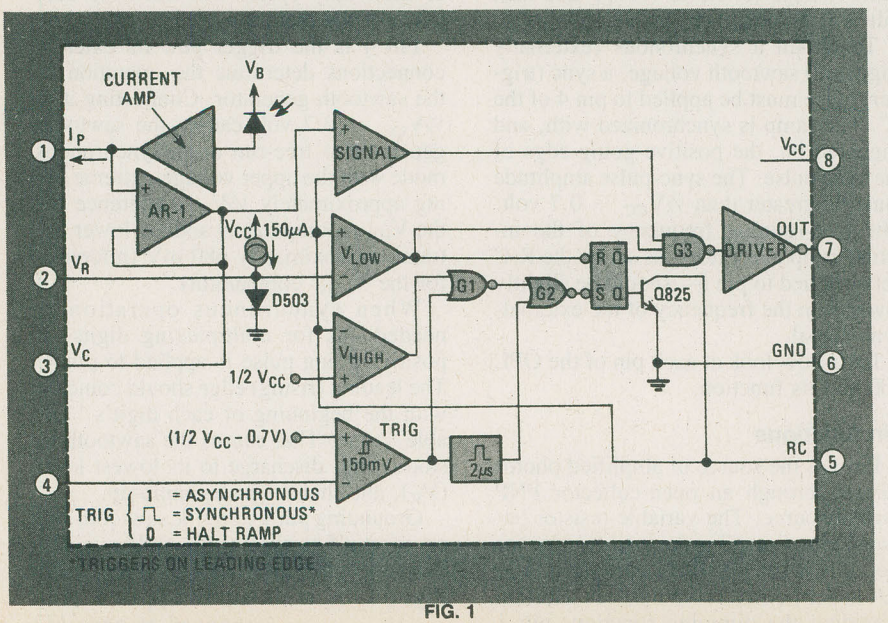

FIG. 1

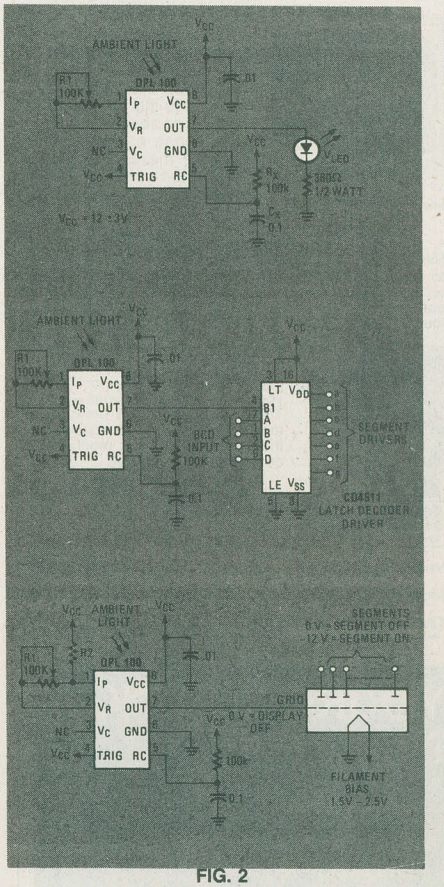

FIG. 2

How the OPL 100 works

Referring to the block diagram in Fig. 1, we see that, in addition to the photodiode, the OPL 100 includes a voltage regulator, a constant-current source, a high-gain temperature-compensated current amplifier, an op-amp, four comparators, an R-S latch, logic including NAND and NOR gates, and an output driver. The width of the device's output pulse is determined by the relationship between an analog control-voltage that is proportional to ambient light, and the instantaneous voltage level of the ramp of an internally generated sawtooth.

The sawtooth frequency is determined by an external R-C network (100K and 0.1 μF in Fig. 2) connected to pin 5 of the IC. The output of the sawtooth generator is connected to the signal comparator. The analog control-voltage—proportional to the ambient light level—is connected to the second input terminal of the signal comparator. The comparator switches on when the control voltage is higher than the instantaneous sawtooth-

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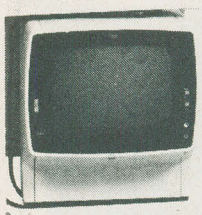

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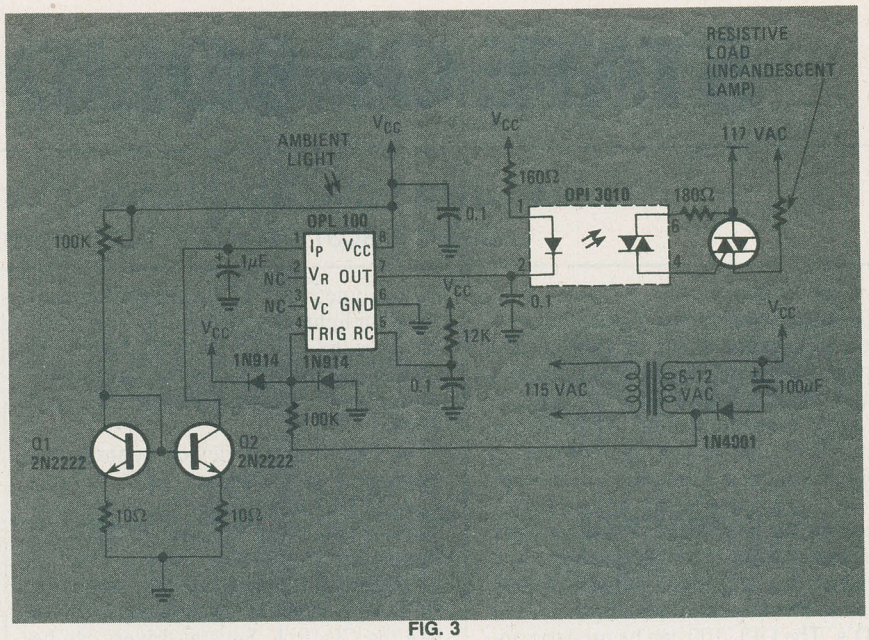

FIG. 3

ramp voltage, and switches off when the control voltage is lower.

The "on" portion of the output pulse and the sawtooth ramp start at the same time. The output-pulse width continues to rise until the ramp voltage is higher than the control voltage V_C. At that point, the signal comparator switches off. Since the control voltage rises with ambient light, we see that as light level increases, V_C rises, causing an increase in the width of the output pulse. That causes an increase in the display brightness.

The sawtooth frequency is approximately $1.44/(R_xC_x)$ where R_x and C_x are the values of the external timing components. The maximum recommended value for R_x is 100K. To obtain an asynchronous (free-running) sawtooth, connect pin 4 of the IC to V_{CC} as shown in the applications in Fig. 2. That lets the ramp voltage to rise to ½ V_{CC} and then fall to 0.7 volt.

To obtain a synchronous (externally triggered) sawtooth voltage, a sync (trigger) pulse must be applied to pin 4 of the IC. The ramp is synchronized with, and triggered on, the positive-going edge of the sync pulse. The sync-pulse amplitude must be greater than ½V_{CC} − 0.7 volt. The free-running frequency of the internal ramp generator—as set by the R-C network tied to pin 5—should be slightly lower than the frequency of the external-sync signal.

Let's now look at each pin of the OPL 100 and its function.

Pin functions

Pin 1 is the source of amplified photocurrent through an open-collector PNP current source. The variable resistor between pins 1 and 2 is the load resistor for the current source. Photocurrent I_P is ½ mA under normal room light. In addition providing the dimming function, pin 1 can be used for on-off control of the display. Connecting pin 1 to V_{CC} forces the output terminal (pin 7) to a logic-1 (V_{CC} − 2 volts), driving the displays to full brilliance. Connecting pin 1 to ground forces pin 7 to logic-0, and turns the display off.

Pin 2 is the source of reference voltage V_R (approximately 680 mV) set by a constant current of approximately 150 μA through diode D503. That voltage determines the lower voltage extreme for the sawtooth waveform. Pin 2 is the tie-point for the lower end of the sensitivity control.

Pin 3 is the source of a buffered analog control-voltage that is proportional to the incident light level. In applications where several OPL 100's are used in a system, control voltage V_C from the main unit is applied to pin 1 on the remote OPL 100's so their duty cycles will track the duty cycle of the main unit.

Pin 4 is the trigger pin. Its external connections determine the operation of the sawtooth generator. Connecting it to ½V_{CC} − 0.7 volt causes the sawtooth generator to free-run in an synchronous mode with the upper voltage-extreme being approximately ½V_{CC} (reference for the V_{HIGH} comparator) and the lower extreme approximately 680 mV (reference for the V_{LOW} comparator).

When synchronous operation is needed—as for multiplexing digits—a positive-going pulse is applied to pin 4. The leading (rising) edge should coincide with the beginning of each digit's "enable" time. That causes the sawtooth to stop rising, discharge to its lowest level (V_R), and then begin its ramp-up.

Grounding pin 4 stops the sawtooth and causes pin 5 to rise to V_{CC} and remain at that level until the ground is lifted and a logic-1 or a pulse is applied (for

continued on page 132

NEW LITERATURE

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TECHNICAL MANUAL AND CATALOG, *Printed-Circuit Drafting Aids,* is 12 pages, color, letter size, and features books, such as *The Design & Drafting of Printed Circuits,* an article on how to make printed-circuit artwork, insertion-type connector patterns, multipurpose, prespaced pads, dual in-line package (DIP) patterns, "TO" style patterns, precision slit PC artwork, tape, PreKut tape shapes, printed-circuit artwork targets, sequential reference designation kits, *X-acto* knives and blades, 8X magnifier, *Accufilm* grids, *Accufilm CTF* (clear taping film), *Accuvel* drafting & tracing pads, *Accufilm* anti-static, stable-based drafting film, and printed-circuit & general purpose templates. The manual is free upon request.—**E-Z CIRCUIT,** Bishop Graphics, Inc., 5388 Sterling Center Drive, PO Box 5007EZ, Westlake Village, CA 91359.

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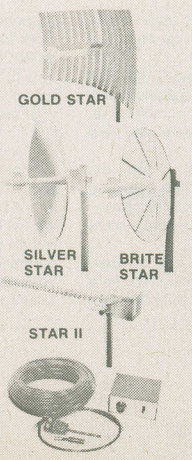

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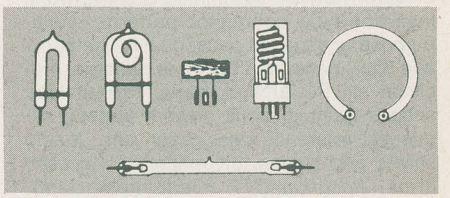

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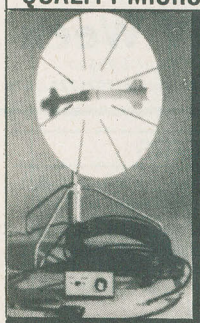

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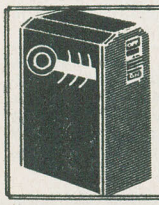

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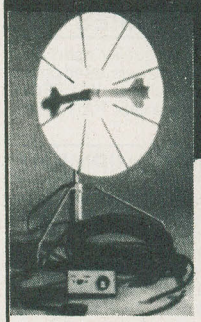

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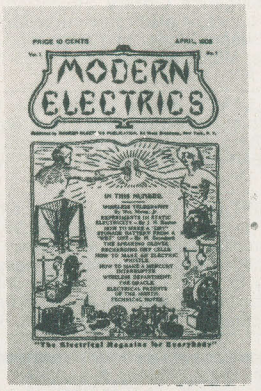

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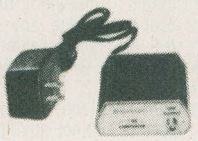

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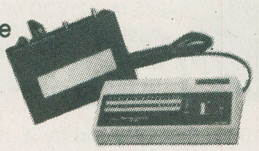

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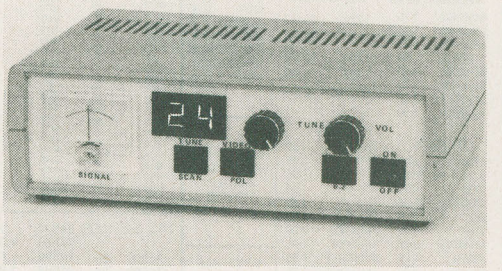

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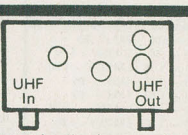

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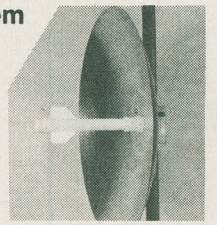

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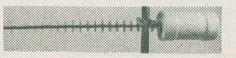

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74S474	3.95

RAM's

21L02-3	.70
2101-1	1.65
2111AL	1.95
2114 -4	1.10
2114 -3	1.50
2147-3	4.95
TMS3409	2.95
MK4008P	1.95
MK4027-3	1.95
TMS4050NL	2.95
MK4096-11	1.95
4116-3	1.10
4116-15	1.50
5101E	2.95
Z6104-4	2.50
6116-3	5.50
8264 (4164-2)	5.75
58725 (MK4802)	5.95

INTER FACE & DRIVERS

1488	.65
1489	.65
8130	2.50
8830	2.50
8131	2.50
8833	2.50
8834	2.00
8837	2.00
MM5307	7.95
BR1941L	8.95
CRT5037	18.95
MM5369	2.50
TR1602B	3.95

NO. 30 WIRE WRAP WIRE SINGLE STRAND
100'...$1.40

CRYSTALS

2.000	6.144
3.000	8.000
3.579	10.000
4.000	18.000
5.000	18.432
6.000	20.000

2.95 ea.

SCR's

	1.5A	6A	35A	110A
100	.35	.40	1.40	
200	.40	.50	1.80	9.00
400	.60	.70	2.40	12.00
600		1.00	3.60	15.00

TRIAC's

PRV	1A	10A	25A
100	.35	.60	1.40
200	.50	.80	1.90
400	.70	1.00	2.60
600	1.00	1.20	3.60

C/MOS

4001	.25	4043	.65	4583	.90
4002	.25	4044	.55	4585	.75
4006	.65	4046	.80	74C00	.27
4007	.27	4047	.95	74C02	.27
4008	.70	4049	.35	74C04	.35
4009	.39	4050	.35	74C08	.30
4010	.45	4051	.80	74C10	.27
4011	.22	4052	.75	74C14	.65
4012	.22	4053	.75	74C20	.27
4013	.35	4060	.80	74C32	.39
4014	.70	4066	.39	74C42	1.00
4015	.39	4068	.35	74C74	.50
4016	.30	4069	.25	74C76	.70
4017	.60	4070	.35	74C85	1.40
4018	.50	4071	.25	74C86	.39
4019	.39	4072	.20	74C90	.90
4020	.70	4076	.65	74C93	.50
4021	.65	4077	.35	74C154	2.50
4022	.75	4081	.25	74C157	1.75
4023	.22	4082	.25	74C160	1.20
4024	.45	4093	.49	74C161	1.15
4025	.25	4099	1.75	74C163	1.15
4026	.95	4501	.95	74C173	.75
4027	.40	4510	.65	74C174	1.15
4028	.55	4511	.65	74C175	1.19
4029	.75	4514	1.25	74C192	1.30
4030	.35	4515	1.50	74C901	.39
4034	1.75	4516	.75	74C902	.70
4035	.75	4518	.85	74C914	1.75
4040	.65	4520	.70	74C921	3.95
4042	.55	4528	1.00	74C83	1.25
		4539	1.25		

74S SERIES

		74S74	.70	74S161	1.75
		74S85	1.25	74S163	1.40
74S00	.30	74S86	.60	74S169	1.75
74S02	.30	74S89	1.90	74S174	1.40
74S03	.30	74S112	.85	74S175	1.40
74S04	.40	74S133	.50	74S182	1.75
74S05	.45	74S135	1.10	74S194	1.10
74S08	.40	74S138	1.25	74S240	1.00
74S10	.30	74S139	1.10	74S241	1.50
74S11	.35	74S140	1.70	74S257	1.30
74S15	.40	74S151	1.25	74S258	1.30
74S20	.40	74S153	.95	74S260	1.50
74S30	.40	74S157	1.25	74S280	1.75
74S32	.40	74S158	1.25	74S373	2.25

LINEAR CIRCUITS

DAQ08EQ — 3.75	LF356 — 1.00	747 — .50
TL062 CP — .95	LM358 — .50	CA758 — 1.75
TL064 CN — 1.50	LM361 — 1.75	LM1310 — 1.60
TL084 — 1.50	LM370 — 1.60	1456 — .80
LM201 — .75	LM377 — 1.60	1458 — .50
LM301/748 — .30	LM380 — .85	LM1808 — 1.75
LM307 — .30	LM383 — 1.90	LM2901 — .95
LM308 — .65	LM386 — .85	CA3018 — 1.95
LM310 — 1.10	LM387 — 1.25	CA3078AT — 1.50
LM311 — .50	LM393 — .75	CA3086 — .75
LM318 — .75	LM555 — .34	AD2700LD — 4.95
LM319 — .95	LM556 — .65	CA3140 — 1.00
LM324 — .55	565 — .95	3900 — .45
LM339 — .65	566 — 1.25	4136 — .85
LM348 — .90	567 — .85	N5596A — 1.50
LF351 — .55	709 — .25	D6303B — 1.75
LF353 — 1.90	710 — .45	8038CC — 3.90
LF355 — .90	711CH — .40	LM13080 — .95
	741CV — .25	CA3089E — 1.75

20KV 250MA DIODE $1.90

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE

S.P. 1200 ohm coil .75

D.P. 400 ohm coil .95

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	4.25	6.00
200	.06	.17	.50	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.13	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

REGULATORS

LM338K	$5.75	323K (LA1405)	$1.75
LM317T	$1.00	LM305G	$ .75
78L05, 78L12	$ .40	340T-5, 6, 8, 9, 12,	
723	$ .50	15, 18 or 24V	$ .85
320T 5, 12, 15 or 24	$ .90	LAS1412 + 12V	
LM 337T	$1.95	3A	$3.95

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 10V	$ .40
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	120UF 6V	$ .75
4.7UF 35V	4/$1.00	200UF 20V	$1.75
6.8UF 20V	4/$1.00	150UF 16V	$1.30
10UF 20V	— $ .40	330UF 10V	$1.75
22UF 10V	— $ .30		

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1/16" thick with 1/10" spacing
4½" x 6½" $1.95

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40 PIN HEADERS	1.10
50 PIN EDGEBOARD CONN.	3.95
26 PIN EDGEBOARD CONN.	2.50
50 PIN ANGLE CONN.	3.95

TRANSISTOR SPECIALS

2N1307 PNP GE TO-5	$ .40
2N404A PNP GE TO-5	3/$1.00
HEP G8014 — PNP GE TO-3	$ .85
TIP 111	$ .50
TIP 145	$1.35
2N6233-NPN SWITCHING POWER	$1.95
MRF-8004 CM RF TRANSISTOR NPN	$ .75
2N3772 NPN Si TO-3	$1.00
2N4908 PNP Si TO-3	$1.00
TIP 295S PNP Si	$ .70
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2N2907 PNP Si TO-18	9/$1.00
2N3055 NPN Si TO-3	$ .60
2N3904 NPN Si TO-92	9/$1.00
2N3906 PNP Si TO-92	$ .55
2N6109 PNP Si TO-220	$ .55
TIP 31B NPN Si TO-220	$ .40
TIP 32B PNP Si TO-220	$ .40
TIP 34 PNP Si	$ .95
TIP 121 PNP Si U84	$ .60
TIP 141 NPN Si U97	$1.00
BU205	$1.75
DPS2000 — DUAL POWER DARL	$3.95
MJE3055T	$ .60

TTL IC SERIES

7400	.17	7472	.30	74612	.60
7401	.17	7473	.35	74163	.60
7402	.17	7474	.32	74164	.60
7403	.17	7475	.40	74165	.60
7404	.24	7476	.35	74166	.70
7405	.24	7480	.45	74170	1.60
7406	.28	7483	.50	74173	.75
7407	.28	7485	.55	74174	.65
7408	.24	7486	.35	74175	.60
7409	.18	7489	1.60	74176	.75
7410	.17	7490	.35	74180	1.90
7411	.22	7491	.45	74182	.45
7412	.30	7492	.45	74190	.70
7413	.35	7493	.35	74191	.75
7414	.45	7494	.60	74193	.79
7416	.25	7495	.55	74194	.85
7417	.25	7496	.60	74195	.45
7420	.17	74107	.30	74196	.75
7425	.25	74116	1.50	74221	1.00
7426	.25	74121	.29	74273	.85
7427	.25	74122	.39	74279	.60
7430	.17	74123	.42	74298	.65
7432	.27	74126	.45	74365	.65
7437	.27	74145	.60	74367	.65
7438	.27	74148	1.10	74390	.90
7440	.17	74150	1.10	75324	1.75
7441	.75	74151	.50	75325	1.50
7442	.45	74153	.40	75492	1.05
7445	.65	75154	1.10	9601	.75
7446	.65	74155	.50	9602	.75
7447	.65	74157	.50	8T26	1.00
7448	.65	74160	.85	8T97	.90
7450	.17	74161	.65	8T98	.90

74LS SERIES

74LS00	.20	74LS109	.36	74LS221	.75
74LS01	.20	74LS112	.38	74LS240	.90
74LS02	.23	74LS113	.45	74LS241	.95
74LS03	.23	74LS114	.55	74LS242	.95
74LS04	.23	74LS123	.75	74LS243	.95
74LS05	.23	74LS125	.45	74LS244	.90
74LS08	.23	74LS126	.45	74LS245	1.38
74LS09	.25	74LS132	.55	74LS446	.95
74LS10	.23	74LS136	.45	74LS247	.75
74LS11	.25	74LS137	.95	74LS248	.95
74LS12	.25	74LS138	.50	74LS251	.55
74LS13	.45	74LS139	.52	74LS253	.55
74LS14	.40	74LS147	1.95	74LS257	.55
74LS15	.35	74LS151	.50	74LS258	.55
74LS20	.23	74LS153	.50	74LS259	1.40
74LS21	.25	74LS154	1.90	74LS266	.52
74LS22	.25	74LS155	.65	74LS273	1.15
74LS26	.35	74LS156	.65	74LS279	.48
74LS27	.23	74LS157	.65	74LS280	1.80
74LS28	.45	74LS158	.65	74LS283	.65
74LS30	.22	74LS160	.70	74LS290	.75
74LS32	.27	74LS161	.70	74LS293	.85
74LS37	.30	74LS162	.65	74LS298	.85
74LS38	.30	74LS163	.65	74LS320	2.00
74LS40	.25	74LS164	.65	74LS323	3.50
74LS42	.44	74LS165	.80	74LS365	.50
74LS47	.65	74LS166	1.25	74LS366	.50
74LS51	.22	74LS169	1.75	74LS367	.50
74LS54	.25	74LS170	1.30	74LS368	.50
74LS73	.35	74LS173	.65	74LS373	.95
74LS74	.35	74LS174	.62	74LS374	.95
74LS75	.35	74LS175	.62	74LS377	1.25
74LS76	.35	74LS181	1.95	74LS386	.45
74LS83	.60	74LS190	.80	74LS390	1.10
74LS85	.65	74LS191	.80	74LS393	1.10
74LS86	.40	74LS192	.75	74LS398	2.50
74LS90	.40	74LS193	.75	74LS625	1.75
74LS92	.55	74LS194	.65	74LS668	1.50
74LS93	.50	74LS195	.65	74LS670	1.20
74LS96	.65	74LS196	.75	74LS682	3.00
74LS107	.36	74LS197	.75	81LS97	1.10
				81LS98	1.10

MULTI TURN TRIM POTS

50 OHM	5K	
100 OHM	10K	
500 OHM	50K	3/$2.00
1000 OHM	500K	

50 PIN RIBBON CONNECTORS $2.25
40 PIN RIBBON CABLE CONN $2.00
34 PIN RIBBON CABLE CONN $2.00
10 PIN RIBBON CABLE CONN $1.00

25 watt Infra Red Pulse (SG 2006 equiv.)
Laser Diode (Spec sheet included) $24.95

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

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.1UF 16V ..... 10/$1.00 ..... 100/$8.00
.01UF 35V ..... 16/$1.00 ..... 100/$5.00

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4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK
$.60 ea. ..... 5/$2.60

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106D — SPDT — .80
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206P — DPDT — CENTER OFF $1.40

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
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YEL, GREEN or AMBER LARGE LED's .2"	6/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .40
MRD14B PHOTO DARL. XTOR	$ .50
MCT2 OPTO ISOLATORS	$ .40
4N26 OPTO ISOLATOR	$ .40
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

FLAT RIBBON CABLE
GRAY
28 gauge
40 conductor .90/ft
26 conductor .60/ft
50 conductor 1.00

DIP SWITCHES

CTS 206- 4	4 POSITION	.75
CTS 206- 7	7 POSITION	.95
CTS 206- 8	8 POSITION	.95
CTS 206-10	10 POSITION	1.25

DIP SOCKETS

8 PIN	.10	22 PIN	.25
14 PIN	.12	24 PIN	.25
16 PIN	.15	28 PIN	.35
18 PIN	.20	40 PIN	.40

WIRE WRAP SOCKETS

8 PIN	—	.40
14 PIN	—	.45
16 PIN	—	.50
18 PIN	—	.65
20 PIN	—	.90
24 PIN	—	1.10
28 PIN	—	1.25
40 PIN	—	1.50

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7808	1.59	2200 40VDC UF	1.89
7815	1.59	1000 UF 16VDC	1.69
1330	1.89	470 35 V	1.09
1350	1.65	220 MFD 25V	.89
1358	2.50	100 MFD 16V	.79
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4558	2.00	4.7 MFD 35V	.36
1458	1.25	1 MFD 50V	.36

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MOST STANDARD VALUES
¼ WATT 5% RESISTORS 1 OHM TO 10 MEG. OHM
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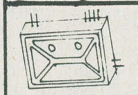
$6.50 ..... Per 1,000



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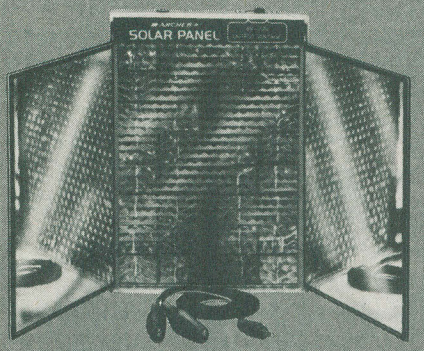

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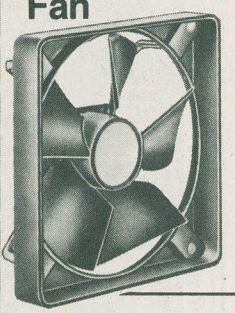
- *Ready to Use*
- *12 or 6VDC Output*
- *32 Full-Spec Cells*

24.95

Converts bright sunlight into approximately 1/2-watt of "free" electrical power. Ideal for charging batteries, it also will power many radios, calculators and small devices directly. Output with full sun: 80 milliamps at 6V, 40 mA at 12V. Includes detachable 5 x 4" reflector panels and 48" plug-in leads with clips. 5 3/4 x 4 1/8 x 5/8". Not for permanent outdoor installation. **277-1250** **24.95**

Compact AC Cooling Fan



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Quiet & Efficient

Perfect for computers, power supplies, ham and hi-fi equipment. Delivers up to 65 CFM. Leads for easy hookup. For 120VAC. 11 watts. U.L. listed. 4 11/16 x 2 1/2". **273-241** **15.95**

50WVDC, Non-Polarized Electrolytics

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For speaker crossover networks, audio filters and much more. Long axial leads.

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10.0	2 kHz	272-999	.99

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Connect Your Microcomputer To The Real World at Low Cost!

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SN75446 Dual Peripheral Driver. Can take a logic-level signal and drive a relay, solenoid or other device directly, up to 350 mA, 50VDC. TTL/MOS compatible diode-clamped inputs. Very low input current. Single 5.5VDC supply. 8-pin DIP with data. Reg. 2.79. **276-2530** ..... **Sale 1.99**

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Gravity-Actuated

Submini position-detecting switch, rated 100 mA at 24VDC. Ideal for models, "motion detector" alarms and more. **275-025** ..... **89¢**

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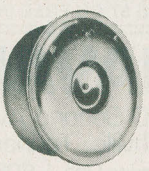

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Low current—great for battery powered security. Metal case with leads. **273-051** **1.89**

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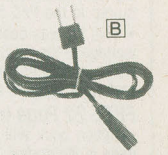

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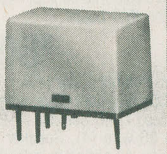

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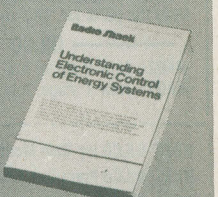

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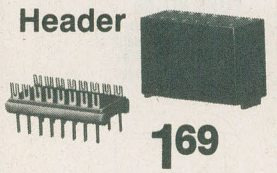

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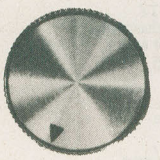

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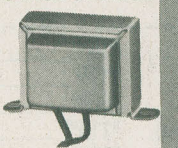

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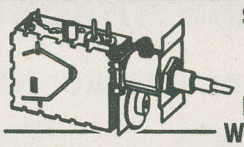

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1. The first thing GILCO does is change the standard diode to a **hot carrier diode**.
2. The tuner's output is then measured on our JERROLD field strength meter and compared to a computer derived chart from which we determine the correct value coil to add across the IF output for ***maximum pre-peaked gain***.
3. The tuner is then fed a standard 10db 300 ohm antenna input and while monitoring the output on our HEWLETT PACKARD spectrum analyzer, the tuner is tuned to the desired channel and its oscillator is offset for the desired output frequency as follows:
   Channel 2: 58 Mhz, Channel 3: 63 Mhz, Channel 4: 68 Hhz

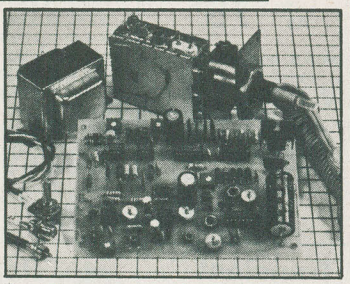
We call this step peaking because the tuner's output looks like a peak on our spectrum analyzer and the highest point of that peak is actually adjusted for the desired output.

4. The last step is one more measurement on the field strength meter which is again compared to our performance chart to calculate the correct value of the second coil which is added to the tuners internal connections.

This procedure was developed by GILCO and it is our computer derived performance charts that make our tuner better, that's because ***almost every tuner gets a different value coil*** before it's peaked and again a different value coil after it's peaked. The combinations are endless and ***the way we determine the values is our secret...***

GILCO PARTS KIT & PRINTED CIRCUIT BOARD

- **Use with GILCO High Gain Tuner**
- **Requires NO Modification to Your Television**
- ***Individually Packaged and Labeled Parts Save Guesswork***



Pre-drilled, pre-screened, plated through the holes P/C board. All hardware, connectors, 22 page illustrated instruction manual, & Gilco Hy-Gain tuner. Kit assembles in just 4 hours.

- The only tools required for assembly are: screwdriver, soldering iron, voltmeter. No drilling is required to the P/C board.
- This kit was designed to take advantage of the GILCO high gain tuner which means its circuitry is ***simpler and more efficient*** than those circuits that require inferior varactor tuners.

FREE 22 Page Instruction Book included with each P/C Board or Parts Kit. This instruction book will guide the builder through every step of the assembly. ***Nearly every page is illustrated***. With this Instruction Book, estimated assembly time is 4 hours.

HERE'S WHAT YOU GET FROM GILCO

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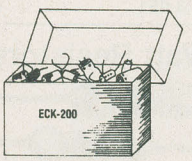

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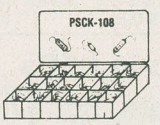

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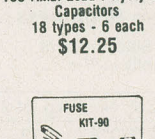

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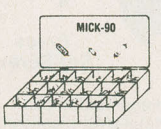

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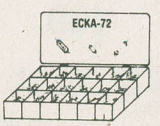

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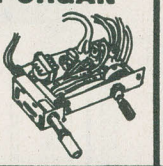

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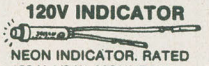

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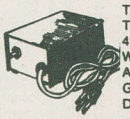
12 VOLT A.C. POWER UNIT



THIS UNIT CONSISTS OF A 12 VOLT 2 AMP TRANSFORMER, 1 AMP CIRCUIT BREAKER, 4 PRONG CINCH JONES SOCKET AND A 3 WIRE A.C. CORD ALL MOUNTED IN AN ATTRACTIVE 4½" x 5½" x 3" CHASSIS BOX. GOOD FOR PARTS OR A NICE START FOR D.C. POWER SUPPLY.

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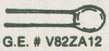

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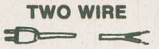

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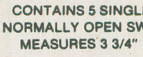

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500K linear taper

2 7/8" LONG
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DUAL 100K audio taper

3 1/2" LONG
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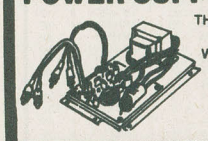
POWER SUPPLY W/ PRE-AMP



THIS SUPPLY WAS USED TO POWER AN 8 TRACK/CASSETTE UNIT. IT WILL SUPPLY APPROX. 18 VDC AND INCLUDES A SMALL PRE-AMP TO BOOST SIGNAL LEVEL. RCA PLUGS FOR LINE IN/OUT.

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3 AMP CONTACTS
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SUPER SMALL SPDT RELAY; GOLD COBALT CONTACTS.
RATED 1 AMP AT 30 VDC; HIGHLY SENSITIVE, TTL DIRECT DRIVE POSSIBLE, OPERATES FROM 4.3 TO 6 V, COIL RES. 220 OHM.

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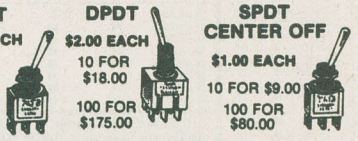

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SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
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74LS13	14	.39	74LS125	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
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74LS20	14	.29	74LS133	16	.59	74LS249	16	1.09
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74LS26	14	.29	74LS139	16	.59	74LS257	16	.59
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74LS54	14	.25	74LS168	16	1.19	74LS367	16	.49
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4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
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4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	**.49 — 8/1.95**
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	2.95
2114	18	1024x4	(450ns)	1.95 - 8/13.95
2114L	18	1024x4	(450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
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2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	8.95
TMS4044	18	4096x1	(450ns)	3.95
TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
MM5257	18	4096x1	(450ns) 4044	4.95
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HM6116-4	24	2048x8	(200ns) CMOS	6.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	7.95
7489	16	16x4	(50ns)	2.25
74C920	22	256x4	(250ns) CMOS (6551)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

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2708-5	24	1024x8	(550ns) SM00246	2.95
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TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
2758Q	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95

PROMS

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74HC32	14	.75	74HC165	16	2.39	74HC688		3.19
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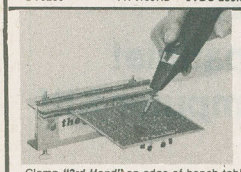

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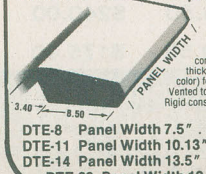
30003	**National Linear Data Book (1982)** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30005	**National TTL Logic Data Book (1981)** (624 pages) 7400,LS,L,H,S, and DM8000 Series	$9.95
30008	**National Memory Data Book (1980)** (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	**Intersil Data Book (1983)** (1356 pages) Complete line.	$9.95
30010	**National Audio/Radio Handbook (1980)** (240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps	$5.95
30011	**National Linear Application Handbook (1980)** (736 pages) Application Notes, Linear Briefs, etc.	$15.95
30012	**National PAL Data Book (1982)** (176 pages) Application Notes, Linear Briefs, etc.	$5.95
30013	**Zilog Data Book (1983)** (641 pages) Microprocessors and Support Chips	$7.95
210830	**Intel Memory Components Handbook (1983)** (798 pages) Contains all Application Notes, Article Reprints, Data Sheets, and other design information on Intel's RAMs, EPROMs, E²PROMs & Bubble Memories.	$14.95
210844	**Intel Microprocessor & Peripheral Handbook (1983)** (1027 pages) Contains Data Sheets on all of Intel's Microprocessors and Peripherals.	$14.95

Universal Computer Keyboard Enclosures

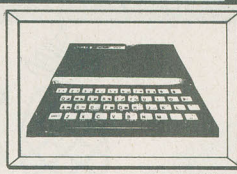


"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8 Panel Width 7.5" $24.95
DTE-11 Panel Width 10.13" $27.95
DTE-14 Panel Width 13.5" $29.95
DTE-20 Panel Width 19.25" $34.95

TIMEX sinclair 1000

- Powerful - fully programmable 2K memory • Portable - 6⅞" x 6⅜" x 1⅜" - 12 oz. • Expandable - Optional 16K RAM module • Single-key entry commands • Educational • Unique syntax-check report codes for error identity • Accurate to 9½ decimal places for full range math and scientific functions • Graph drawing and animated display • Advanced 4-chip design combining power, portability and affordable price.



TS1000 ..... $69.95

ACCESSORIES FOR TIMEX sinclair 1000 and ZX81

TIMEX sinclair 1016 Expansion from 2K to 16K - Size: 3" x 3" x 1.5" - 5 oz. **TS1016 $49.95**

Keyboard Mask for Your ZX81/1000* Computer

BRAND NEW!!

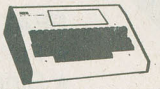
FEATURES:
- Install in seconds. Remove adhesive backing from mask and place over keyboard.
- All characters and symbols reproduced on mask.
- Durable — formed with poly-carbonite sheet-satin finish.

JE681 KEYBOARD MASK

The JE681 Keyboard Mask provides users of the ZX81/1000 series computer the individual feel of each keypad on the keyboard. The mask has a raised outline around each keypad allowing the user to feel and correctly position their fingers onto the keyboard.

JE681 KEYBOARD MASK ..... $9.95 each

Jameco ELECTRONICS ZX81/1000* Keyboard Conversion Kit



JE682-AK KEYBOARD KIT MOUNTED IN DTE-AK ENCLOSURE. LIGHT TAN PANELS WITH MOLDED DARK BROWN END PIECES. SIZE: 14¼"W x 3½"D x 3½"H

The JE682 Kit provides users of the ZX81/1000 series computers a full-size industrial keyboard hook-up to their computer. The JE682 Kit allows the use of either the full-size keyboard or the Sinclair/Timex Keyboard. The Kit also permits the simple disconnection of the Sinclair/Timex Keyboard for portable use. The JE682 Kit consists of a full-size industrial grade keyboard with 62 keys, 2 p.c. boards, 24" ribbon cable, DIP socket and 4 rubber feet. The keyboard conversion kit can easily be mounted into the DTE-AK enclosure. This enclosure is large enough to contain the ZX81/1000 computer and the full-size keyboard together. A handy label representing the ZX81/1000 keyboard layout is placed on the enclosure.

JE682 Keyboard Conversion Kit ..... $59.95 ea.
(WITHOUT DTE-AK CASE)
DTE-AK CASE ONLY ..... $49.95 each
JE682-AK Keyboard Conversion Kit ..... $99.95 ea.
(WITH DTE-AK CASE - AS PICTURED)

*ZX81/1000 IS A TRADEMARK OF SINCLAIR/TIMEX

QUANTITY DISCOUNTS AVAILABLE!

80-Key Keyboard

CA150C $69.95

84-Key Keyboard

CA153A $69.95

95-Key Keyboard

CA154A $79.95

CONTROL DATA KEYBOARDS

Limited Quantities!

- ★ Parallel ASCII
- ★ SPST Switching
- ★ FTZ Shielded Base
- ★ N-Key Rollover
- ★ 128 Character ASCII
- ★ Non-Slip, Non-Glare Keycaps
- ★ CDC752 Terminal Keyboards
- ★ Attractive Case

These Control Data Keyboards consist of a base, cover, the keyboard assembly, and an interface cable. Color (case): Harvest gold and black. Color (keycaps): Black, blue, and red. Electrical requirements: +5V @ 600mA, -12V @ 50mA. Weight: 6 lbs. All units brand new in original boxes, specifications included.

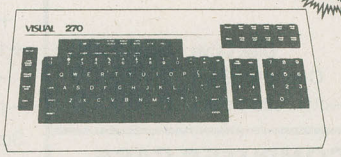
Keytronics 90-Key Soft-Programmable Keyboard

WITH SECURITY KEYLOCK SWITCH

350 Available!

- RFI shielded
- Cursor controls
- Numeric keyboard
- 8-bit Parallel
- Capacitance keys
- 10 user-programmable keys
- Positive TTL Logic
- Size: 17"L x 8¼"W x 2¾"H

BRAND NEW!!



Made for Visual Technology, this keyboard features: a security keylock (includes two keys) to guard against unauthorized use; an 11-key numeric keypad; cursor controls; and 10 user-programmable keys. Electrical requirements: +5VDC. Color (case): White. Color (keycaps): Black. Complete with case, keyboard assembly, 40-inch interface cable, and schematics.

Part No. KB270 ..... $109.95 each

23"L x 5¾"W x 1-3/8"H

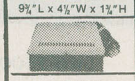
MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
Part No. 85SD18-1 ..... $29.95 each

3"L x 3"W x 1½"H

HI-TEK 14-KEY NUMERIC KEYPAD
SPST switching. Charcoal grey keycaps. Mounted on printed circuit board.
Part No. K-14 ..... $9.95 each

9¾"L x 4⅛"W x 1¾"H

ALPS 29-KEY CALCULATOR KEYBOARD
Features one 8-position decimal select switch, one 3-position switch, and two 2-position switches, mechanical SPST switching, 22-pin edge card connection. Pin-out included.
Part No. KB297040 (Fits DTE-11 Enclosure) ..... $4.95 each



POWER SUPPLY +5VDC @ 1 AMP REGULATED *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¾"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194S ..... $14.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. QPS-1 ..... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94VOS ..... $39.95 each

POWER SUPPLY 4-Channel Switching - Apple Compatible
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%, Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ± 10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A ..... $69.95 each

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California Residents Add 6½% Sales Tax
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5¼" Mini-Floppy Disk Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I (Industry Standard)
Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at right (does not incl. case, power supply, cables). 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No.	*Limited Quantity!*	Price
FD200	Single-sided, 40 tracks, 250K bytes capacity	$179.95
FD250	Double-sided, 35 tracks, 438K bytes capacity	$199.95

Siemens 8" Floppy Disk Drive

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.		Price
FDD100-8	Buy 1 for	$269.95 each
FDD100-8	Buy 2 for	$259.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

2708,2716,2732 & 2764 EPROM Programmer

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES
Self-Contained — Requires No Additional Systems for Operation

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, ◄ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¼"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word Lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers.

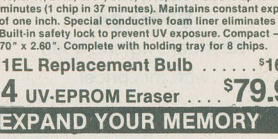
JE664-ARS EPROM Prog. w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716,TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12, +12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM32C	2732A(21V)	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C*	TMS2564	TI	$14.95
JM64D	HN482764G-4	Hitachi (21V)	$14.95

UV-EPROM Eraser

8 Chips — 51 Minutes



1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

UVS-11EL Replacement Bulb $16.95

DE-4 UV-EPROM Eraser $79.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K or 48K

**Model 1 =	From 4K to 16K Requires (1) One Kit
Model 3 =	From 4K to 48K Requires (3) Three Kits
Color =	From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

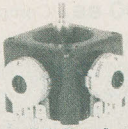
TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 each 4164-2 (200ns) 64K dynamic RAMs and conversion documentation. Converts TRS-80 color computers with D and E circuit boards, and all new color computers to 32K. Minor modifications of 32K memory will allow the use of all 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 ..... $54.95

JOYSTICKS



JS-5K (Pictured)

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95
JS KNOB	Knob for JS5K,100K,150K	$.99 ea.
JVC KNOB	Knob for JVC-40	$.99 ea.

JUNE 1983

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FEATURES:

- ★ Fully compatible with Apple® II+
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- ★ Popular 6502 MPU for large amount of software
- ★ Game paddle connector on both sides of case
- ★ Built in 2-watt amplifier for realistic sound effect with volume control
- ★ 8 on board peripheral connectors for expansion
- ★ 14 key numeric key-pad
- ★ 5-amp switching power supply

Easy to assemble! All components are clearly silk-screened on the high quality double-sided mother board. All integrated circuits, IC sockets, peripheral connectors, keyboard, switching power supply and the professional high impact plastic case are included.

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100% Made In USA 100% Apple and Pineapple™ Compatible
50% Faster Seeking Time Than Apple Disk II Drive!

- 1 Year Full Warranty
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The APPLE II LOOKALIKE COMPUTER CASE

Made with high impact plastic. Color and shape are compatible with the APPLE II

Buy while they last
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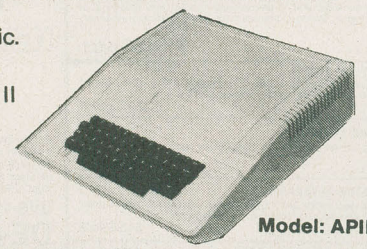
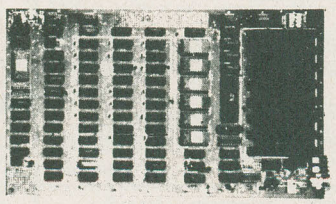
Keyboard not included with this price!



Model: APII

6502 CPU MOTHER BOARD

- 48K on board RAM (4116)
- 12K on board ROM (2716)
- Upper/lower case
- Composite-video output
- Apple II alternative
- Size: 14¼" x 8½"



P.C. Board Only **$99.00 ea.** Complete Component Pack **$250.00**

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Buy them in kit form.
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16K RAM card (cable-less) kit	**$59.50**		

HEAVY DUTY SWITCHING POWER SUPPLY for Apple II, AP-II™ and Pineapple™ Computers

+5V at 5.0 Amp
+12V at 2.5 Amp
−5V at 0.5 Amp
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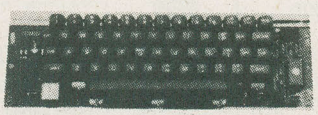
Size and mounting holes are same as the ones used in the Apple II

Model: THB-43H

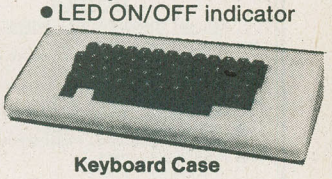
$145.00 ea.

APPLE II+ COMPATIBLE KEYBOARD

- LSI keyboard decoder
- Upper/lower case function
- Full ASCII code output
- N-key rollover function
- LED ON/OFF indicator



LKB-3600-N



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Keyboard Only **$99.00 EA.** Plastic Case **$35.00 EA.**

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All diskettes soft sector single-side double density with hub rings.

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Shipping & Handling Charges	Under $50.00 Purchase	Under $50.00 Purchase
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MC 1496	1.50
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7812	.75
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7818	.75
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2N2222A	.30
MC1349	1.39

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.47 uh	100 uh
15 uh	10 mh
18 uh	69¢ each

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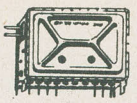

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300 ohm INPUT **$17.95**

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1-.22 mfd	(m)	1-1200 pf	(s)
2-10 pf	(s)	1-3000 pf	(s) or
1-43 pf	(s)	3300 pf	(s)

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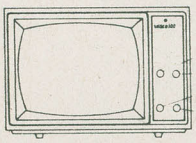

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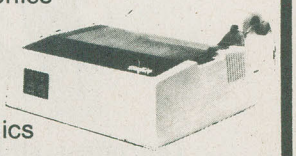

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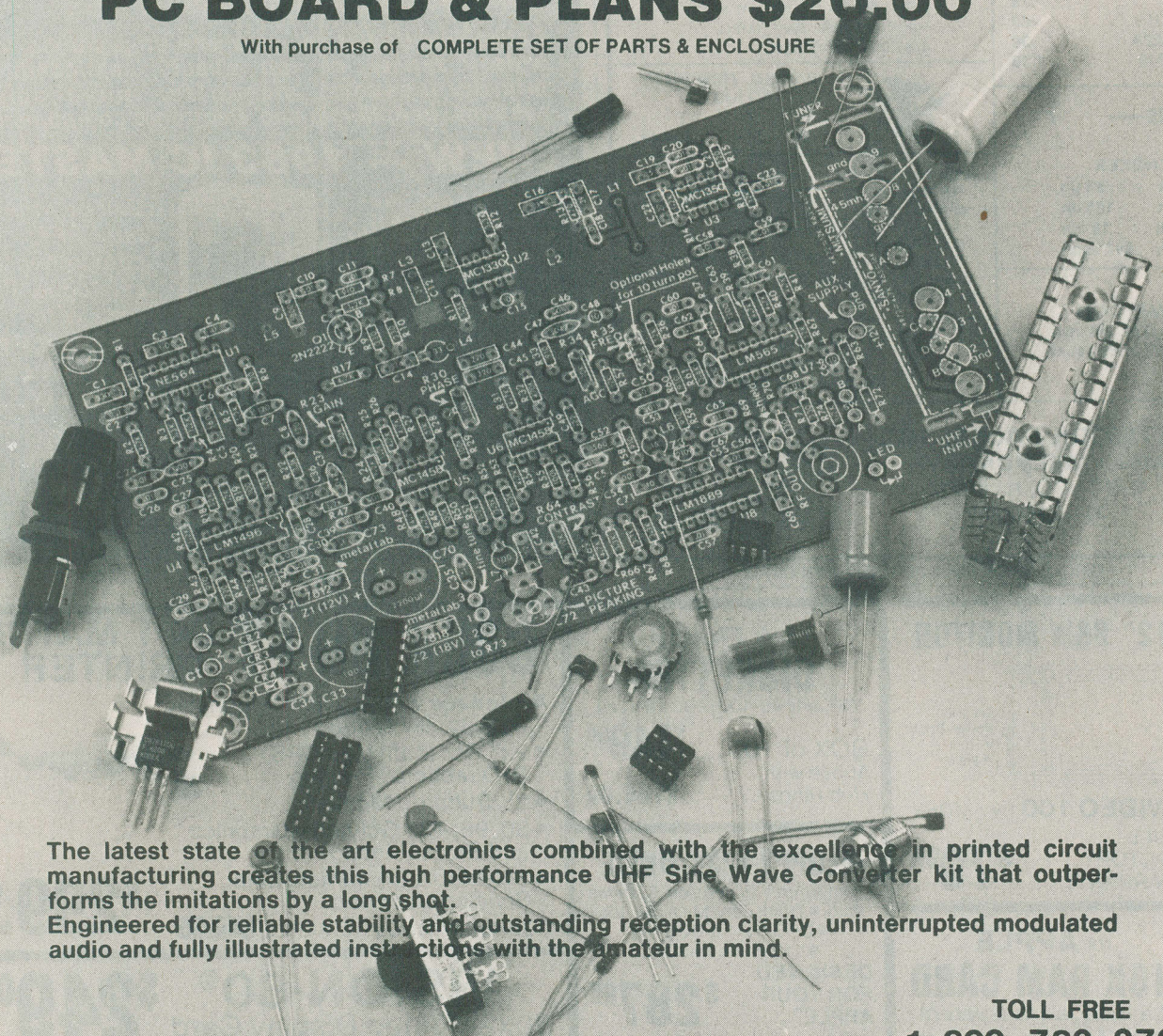

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10/75	12/1.00	**BI-POLAR**	
47/100	**5/1.00***	4/50	10/1.00
1500/100	**2/1.00***	10/50	10/1.00
2.2/150	12/1.00	4.7/75	4/1.00
3.3/150	12/1.00	10/75	4/1.00
47/200	5/1.00	Carbide Drill Bits $1.00 ea. (various sizes to 3/8")	

● $1.00 SPECIALS ●

• Yes All Prices Are Correct! • $10.00 Minimum Order on All Above Capacitors • Some Quantity Pricing Available •

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1N4001	15/$1.00	Horz P.C. Trimpots, 250Ω, 500Ω, 5kΩ, 10Ω	4/$1
2N3905	5/$1.00	MC3420P	$1.00
2SC828	5/$1.00	SN75150	$1.00
2SC644	5/$1.00	Transformer	$1.00
MINI D.P.D.T. Slide	4/$1	12 V.C.T. 250 MA	
D.P.D.T. Rocker Sw		7805	2/$1.00
4A. 120 VAC	3/$1.00	7812	2/$1.00
1N4152	25/$1.00	1N5239	20/$1.00
Similar to 1N914		9 V. ZENER	
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12V 6 A.H. Re-chargeable

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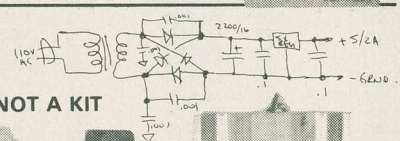

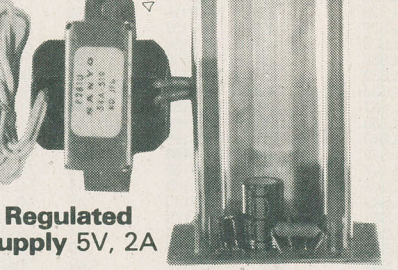

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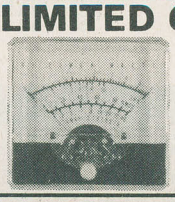

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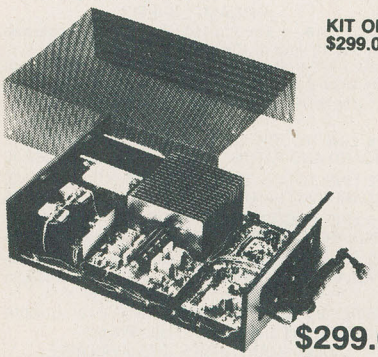

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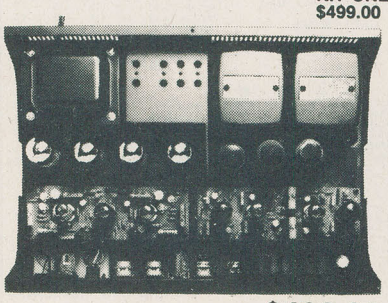

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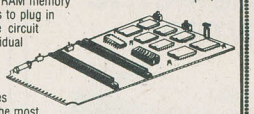

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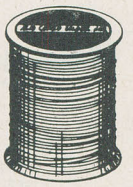

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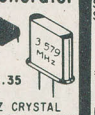

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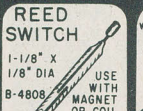

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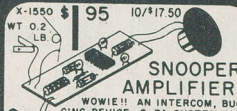

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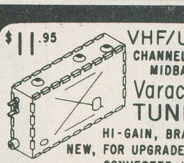

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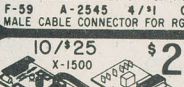

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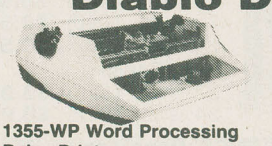

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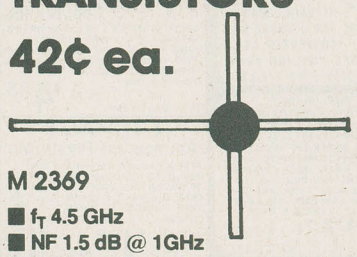

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1N4001	.09	.07	.06
1N4007	.14	.11	.09
1N4148 (1N914)	.07	.05	.032

LEDs — discrete

FIRST QUALITY DISCRETE LEDs
UNIFORM COLOR & INTENSITY
T-1 (subminn.) & T-1 3/4 (jumbo)
Red Green Yellow - DIFFUSED

each	10-	25-	100-	1000-
Red	$.25	$.18ea	$.16ea	$.14ea $.13ea
Green	.25	.18	.16	.14 .13
Yellow	.25	.20	.18	.16 .15

TOGGLE SWITCHES

MINIATURE TOGGLE SWITCH -5amp.

each	10-	*100-	*1000-
SPDT	$1.00	$.90	$.80 $.75
DPDT	1.10	1.00	.90 .85

*any mix of toggle switches

TRANSISTORS

	each	10-	100-	1000-
MPSA06	TO-92	$.25	$.17ea	$.12ea $.11ea
2N2222A	TO-92	.30	.18	.15 .13
2N2222A	TO-18	.45	.35	.25 .23
2N3053	TO-5	.55	.50	.45 .42
2N3904	TO-92	.25	.17	.12 .10
2N3906	TO-92	.25	.17	.12 .10

CAPACITORS

POLYESTER FILM 100V ± 10%

each	10-	100-	1000-
.001uf	$.20	$.10ea	$.07ea $.06ea
.0015uf	.20	.10	.07 .06
.0022uf	.20	.10	.07 .06
.0033uf	.20	.10	.07 .06
.0047uf	.20	.10	.07 .06
.0068uf	.20	.10	.07 .06
.01uf	.20	.10	.07 .06
.015uf	.20	.10	.08 .06
.022uf	.20	.10	.09 .07
.033uf	.20	.10	.09 .08
.047uf	.20	.11	.10 .09
.068uf	.25	.12	.11 .10
.1uf	.30	.17	.13 .11
.15uf	.35	.22	.14 .12
.22uf	.40	.25	.20 .17
.33uf	.45	.27	.25 .21
.47uf	.50	.35	.30 .27

POLYESTER CAPACITOR ASSORTMENT

P-5 5 each of above...$14.95
P-10 10 each of above..$22.50

DIPSWITCHES

	SPST 1-	*10-	*25-
4sw 8pin	$1.70	$1.50	$.95
8sw 16pin	1.80	1.65	1.25
10sw 20pin	2.00	1.85	1.45

*any mix of dipswitches

CERAMIC DISC CAPACITORS

1pf 47pf 220pf .0047uf
5pf 56pf 270pf .010uf
7pf 68pf 390pf .015uf
10pf 82pf 470pf .022uf
18pf 100pf 600pf .030uf
22pf 120pf .001uf .050uf
27pf 150pf .0015uf .1uf
33pf 180pf .003uf

1pf - .050uf

each	10-	100-	*1000-	*5000-
$.20	$.10ea	$.07ea	$.06ea	$.05ea

.1uf

each	10-	100-	*1000-	*5000-
$.25	$.13ea	$.10ea	$.09ea	$.085ea

*1000 & 5000 piece may be used for any mix of values (min of 100ea)

ELECTRONIC BUZZER

miniature - solid state
6 Volt (operates from 4V - 9V)

each	10-	100-	500-
$1.35	$1.10ea	$1.00ea	$.95ea

CERAMIC CAPACITOR ASSORTMENT

C-5 5 each of above....$12.95
C-10 10 each of above...$22.50

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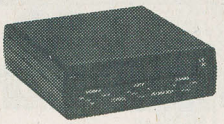
IEU Inc.
435 First St., Solvang, CA 93463
(805) 688-2747

CIRCLE 11 ON FREE INFORMATION CARD

ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED



PRICES

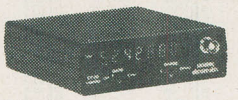
CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED



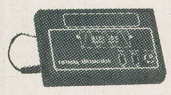
SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95



7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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2575 BAIRD RD. • PENFIELD, NY 14526

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INTEGRATED CIRCUITS

7400 TTL

Part	Price
7400N	.39
7401N	.39
7402N	.39
7403N	.39
7404N	.41
7405N	.41
7406N	.43
7407N	.43
7408N	.41
7409N	.43
7410N	.39
7411N	.39
7413N	.48
7414N	.57
7416N	.43
7417N	.43
7420N	.39
7423N	.44
7425N	.43
7426N	.41
7427N	.41
7430N	.39
7432N	.41
7437N	.41
7438N	.41
7440N	.39
7441AN	1.16
7442N	.59
7443N	.81
7444N	.81
7445N	.93
7446N	1.03
7447N	1.03
7448N	1.03
7450N	.39
7451N	.39
7453N	.39
7454N	.39
7460N	.40
7470N	.52
7472N	.52
7473N	.50
7474N	.46
7475N	.57
7476N	.46
7483N	.83
7485N	.73
7486N	.46
7489N	3.08
7490N	.57
7491N	.88
7492N	.58
7493N	.57
7495N	.64
7496N	.74
74107N	.46
74109N	.46
74121N	.55
74123N	.59
74125N	.64
74126N	.64
74132N	.70
74141N	1.16
74145N	.93
74147N	1.70
74148N	1.28
74150N	1.36
74151N	.64
74153N	.61
74154N	1.29
74155N	.67
74156N	.67
74157N	.64
74158N	1.73
74160N	.82
74161N	.88
74162N	.91
74163N	.86
74164N	.86
74165N	.92
74166N	.92
74170N	1.84
74173N	1.22
74174N	.68
74175N	.68
74176N	.94
74177N	.94
74180N	.99
74181N	1.96
74182N	1.07
74184N	3.66
74185N	3.66
74190N	1.01
74191N	.94
74192N	1.05
74193N	.86
74194N	.86
74195N	.68
74196N	.90
74197N	.90
74198N	1.74
74199N	1.74
74251N	1.10
74365N	.75
74366N	.75
74367N	.75
74368N	.75
8093N	.64
8094N	.64
8095N	.75
8096N	.75
8097N	.75
8098N	.75
8334N	2.41

A/D& D/A

Part	Price
ADC0803LCN	7.85
ADC0804LCN	4.85
ADC0805LCN	5.60
ADC0808CCN	12.64
ADC0809CCN	5.39
ADC0816CCN	22.32
ADC0817CCN	13.20
ADC0833CCN	4.75
ADC1001CCN	22.50
ADC1021CCN	24.75
ADC3511CCN	7.56
ADC3711CCN	7.56
ADD3501CCN	8.26
ADD3701CCN	8.26
DAC0800LCN	2.57
DAC0807LCN	1.95
DAC0808LCN	2.07
DAC0830LCN	6.85
DAC0832LCN	3.85
DAC1020LCN	10.70
DAC1022LCN	7.07
MM5314N	3.89
MM5369N	1.55
MM5837N	1.67

Memory

Part	Price
93410PC	3.13
1702	5.48
MM2102AN-4L	1.76
MM2114N	3.00
MM2114N-3L	3.70
MM2114N-L	3.20
MM2147N	5.60
MM2716Q	4.95
MM2716Q-5	3.75
4116N-200	1.95
5290N-200	1.95
MM5257N	5.20
MM5280N-055	2.31
MM5314N	3.98
MM5369N	2.80
MM5837	2.30
74S570N	4.27
74S571N	4.27
74S572N	7.61
74S573N	7.61
MM2732Q	12.50
NMC27C16Q-45	20.10

Compare the Discount when comparing Prices

74LS00 TTL

Part	Price
74LS00N	.39
74LS01N	.39
74LS02N	.39
74LS03N	.39
74LS04N	.41
74LS05N	.41
74LS08N	.41
74LS09N	.43
74LS10N	.39
74LS11N	.40
74LS12N	.39
74LS13N	.50
74LS14N	.64
74LS15N	.40
74LS20N	.39
74LS21N	.40
74LS22N	.39
74LS26N	.43
74LS27N	.41
74LS30N	.39
74LS32N	.43
74LS37N	.43
74LS38N	.43
74LS40N	.40
74LS42N	.67
74LS47N	1.05
74LS48N	1.05
74LS49N	1.03
74LS51N	.39
74LS54N	.39
74LS55N	.39
74LS73N	.47
74LS74N	.46
74LS75N	.55
74LS76N	.51
74LS78N	.49
74LS83AN	.89
74LS85N	.96
74LS86N	.50
74LS90N	.68
74LS93N	.68
74LS107N	.46
74LS109N	.46
74LS112N	.49
74LS113N	.52
74LS114N	.52
74LS122N	.72
74LS123N	.87
74LS125N	.56
74LS126N	.56
74LS132N	.64
74LS136N	.48
74LS138N	.66
74LS139N	.66
74LS151N	.68
74LS153N	.64
74LS154N	1.40
74LS155N	.68
74LS156N	.68
74LS157N	.68
74LS158N	.68
74LS160N	.93
74LS161N	.86
74LS162N	.86
74LS163N	.86
74LS164N	.88
74LS168N	1.48
74LS169N	1.48
74LS170N	1.84
74LS173N	.84
74LS174N	.70
74LS175N	.70
74LS190N	1.05
74LS191N	1.05
74LS192N	1.01
74LS193N	1.01
74LS195AN	.83
74LS196N	1.26
74LS197N	.94
74LS221N	1.07
74LS240N	1.37
74LS241N	1.37
74LS242N	1.37
74LS243N	1.37
74LS244N	1.40
74LS247N	1.39
74LS248N	1.39
74LS249N	1.39
74LS251N	.74
74LS253N	.73
74LS257N	.76
74LS258N	.74
74LS266N	.50
74LS279N	.58
74LS283N	.83
74LS290N	.97
74LS293N	.97
74LS295N	1.26
74LS298N	1.23
74LS352N	1.48
74LS353N	1.48
74LS365N	.62
74LS366N	.62
74LS367N	.62
74LS368N	.62
74LS373N	1.53
74LS374N	1.53
74LS386N	.54
74LS395N	1.96
74LS670N	2.11
81LS95N	1.73
81LS96N	1.73
81LS97N	1.73
81LS98N	1.73

Micro.

Part	Price
COP402N	7.27
COP404LSN	12.19
COP444LR	66.00
COP452N	5.20
COP470N	4.05
COP472N	5.25
COP498N	5.20
COP499N	5.20
DP8212N	1.57
DP8216N	1.42
DP8224N	1.98
DP8226N	1.42
DP8228N	3.30
DP8238N	3.30
DP8303N	3.20
DP8304BN	3.20
DP8307N	3.20
DP8308N	3.20
DP8310N	5.33
DP8311N	5.33
INS8035LN-6	6.57
INS8035N-11	6.82
INS8039N-6	5.32
INS8039N-11	6.82
INS8060N	18.45
INS8073N	33.93
INS8080AN	4.89
INS8154N	15.59
INS8251N	6.99
INS8253N	12.05
INS8254N	10.53
INS8255N	6.70
INS8259N	9.24
ISP-8F/352	15.00
MM58167AN	9.35
MM58174AN	8.84
MSM5832	9.38
NSC800N	47.02
NSC800N-1	29.02
NSC810N-1	22.68
DM8334N	2.41

DIGI-KEY Volume Discount

74S00 TTL

Part	Price
74S00N	.50
74S02N	.50
74S03N	.50
74S04N	.53
74S05N	.53
74S08N	.50
74S09N	.50
74S10N	.50
74S11N	.50
74S15N	.50
74S20N	.50
74S22N	.50
74S30N	.50
74S32N	.55
74S40N	.50
74S51N	.50
74S64N	.50
74S65N	.50
74S74N	.67
74S86N	.67
74S112N	.69
74S113N	.67
74S114N	.72
74S133N	.55
74S134N	.64
74S135N	.86
74S136N	1.85
74S138N	.98
74S139N	.98
74S140N	.67
74S151N	1.19
74S153N	1.19
74S157N	1.19
74S158N	1.19
74S160N	3.64
74S161N	3.64
74S162N	3.64
74S163N	3.64
74S174N	1.19
74S175N	1.19
74S181N	5.33
74S182N	2.08
74S188N	2.44
74S189N	4.03
74S194N	2.08
74S195N	2.08
74S196N	2.30
74S197N	2.30
74S200N	7.87
74S206N	7.87
74S240N	2.81
74S241N	2.81
74S242N	3.38
74S243N	3.38
74S244N	3.41
74S251N	1.22
74S253N	1.22
74S257N	1.22
74S258N	1.22
74S280N	2.30
74S283N	3.52
74S287N	2.59
74S288N	2.44
74S289N	4.03
74S373N	3.05
74S374N	3.05
74S387N	2.59
74S472AN	9.05
74S473AN	9.05
74S474AN	9.05
74S475AN	9.05
74S570N	4.27
74S571N	4.27
74S572N	7.61
74S573N	7.61
74S940N	3.41
74S941N	3.41

74C00 CMOS

Part	Price
74C00N	.40
74C02N	.40
74C04N	.36
74C08N	.40
74C10N	.40
74C14N	.67
74C20N	.40
74C30N	.40
74C32N	.45
74C42N	.98
74C48N	1.23
74C73N	.61
74C74N	.58
74C76N	.62
74C83N	1.48
74C85N	1.48
74C86N	.36
74C89N	4.54
74C90N	1.12
74C93N	1.12
74C95N	1.37
74C107N	.61
74C150N	3.63
74C151N	2.38
74C154N	3.63
74C157N	2.38
74C160N	1.03
74C161N	1.03
74C162N	1.03
74C163N	1.03
74C164N	1.15
74C165N	1.16
74C173N	.96
74C174N	.94
74C175N	.89
74C192N	1.03
74C193N	1.03
74C195N	1.03
74C200N	8.36
74C221N	1.41
74C240N	1.78
74C244N	1.78
74C373N	2.27
74C374N	2.27
74C901N	.52
74C902N	.52
74C903N	.52
74C904N	.52
74C905N	7.48
74C906N	.52
74C907N	.52
74C908N	1.21
74C909N	2.24
74C910N	6.12
74C911N	9.53
74C912N	9.53
74C914N	.88
74C915N	1.51
74C917N	9.53
74C918N	1.46
74C922N	3.83
74C923N	3.83
74C925N	5.66
74C926N	5.67
74C927N	5.67
74C928N	5.67
74C932N	1.14
74C941N	1.80
80C95N	.53
80C96N	.53
80C97	.49
80C98	.53
82C19N	3.63
88C29N	1.98
88C30N	1.98

Interface

Part	Price
DS1488N	.90
DS1489AN	.90
DS1489N	.90
75450N	.72
75451N	.59
75452N	.59
75453N	.59
75454N	.59
75491N	.85
75492N	.85
75493N	1.04
75494N	1.04

INTEGRATED CIRCUITS

4000 CMOS

Part	Price
4000	.36
4001B	.36
4002B	.36
4006A	1.03
4007A	.36
4008B	1.06
4009A	.47
4010A	.47
4011B	.37
4012B	.36
4013B	.60
4014B	.92
4015B	.87
4016B	.45
4017B	.87
4018B	.92
4019B	.47
4020B	.87
4021B	.89
4022B	.94
4023B	.36
4024B	.76
4025B	.36
4027B	.56
4028B	.80
4029B	.96
4030A	.45
4031B	1.35
4034B	2.08
4035B	1.07
4040B	.89
4041A	.85
4042B	.80
4043B	.87
4044B	.87
4046B	1.01
4047B	.97
4048B	.45
4049A	.47
4050B	.47
4051B	.94
4052B	.96
4053B	.92
4060B	1.05
4066B	.45
4069A	.36
4070B	.36
4071B	.36
4073B	.36
4075B	.36
4076B	.96
4081B	.37
4082B	.36
4089B	1.66
4093B	.54
4099B	1.30
40106B	.67
40160B	1.03
40161B	1.03
40162B	1.03
40163B	1.03
40174B	.94
40175B	.89
40192B	1.03
40193B	1.03
40195B	1.03
4503B	.49
4510B	1.01
4511B	1.12
4512	1.01
4514B	1.99
4515B	1.99
4516B	1.07
4518B	1.07
4519B	.49
4520B	.94
4522B	1.16
4526B	1.19
4527B	1.21
4528B	1.19
4529B	1.39
4541B	1.20
4543B	1.21
4584B	.67
4723B	1.34
4724B	1.34

Linear

Part	Price
LF347N	2.19
LF351N	.67
LF353N	1.12
LF355N	1.40
LF356N	1.40
LF357N	1.40
LF398N	4.25
LF357N	1.40
LF411CN	.99
LF412CN	1.64
LF441CN	.89
LF444CN	2.52
LF13741N	.67
LM10CLN	3.77
LM11CLN	2.39
LM301AN	.50
LM307N	.62
LM308N	.75
LM311N	.75
LM317K	4.64
LM317LZ	.92
LM317MP	1.37
LM317T	1.59
LM318N	2.12
LM319N	2.31
LM320LZ-5.0	.96
LM320LZ-12	.96
LM320LZ-15	.96
LM320MP-5	1.69
LM320MP-6	1.69
LM320MP-8	1.69
LM320MP-9	1.69
LM320MP-12	1.69
LM320MP-15	1.69
LM320MP-24	1.69
LM322N	1.84
LM323K	7.64
LM324N	.76
LM325N	3.41
LM326N	3.41
LM327N	3.41
LM329DZ	.76
LM331N	5.30
LM334Z	1.51
LM335Z	1.76
LM336Z-2.5	1.26
LM336Z-5.0	1.26
LM337K	6.89
LM337MP	1.57
LM337T	2.42
LM338K	9.26
LM339N	.71
LM340KC-5	2.01
LM340KC-12	2.01
LM340KC-15	2.01
LM340T-5	1.24
LM340T-12	1.24
LM340T-15	1.24
LM341P-5	.99
LM341P-6	.99
LM341P-12	.99
LM341P-15	.99
LM341P-18	.99
LM341P-24	.99
LM346N	3.20
LM348N	1.11
LM349N	1.59
LM350K	7.14
LM350T	4.74
LM358N	.65
LM359N	2.02
LM376N	.80
LM377N	1.46
LM378N	2.44
LM379S	2.79
LM380N	1.04
LM380N-8	1.15
LM381N	1.91
LM382N	1.41
LM383AT	3.53
LM384N	1.79
LM386N-1	.65
LM387N	.80

Linear

Part	Price
LM388N-3	.99
LM389N	1.10
LM390N	.94
LM391N60	1.25
LM391N80	1.75
LM392N	.87
LM393N	.75
LM395K	6.51
LM395P	2.07
LM395T	2.54
LM396K	20.00
LM555CN	.65
LM556CN	1.04
LM565CN	1.30
LM566CN	2.17
LM567CN	1.30
LM709CN	.79
LM723CN	.66
LM725CN	2.54
LM733CN	1.16
LM741CN	.55
LM747CN	.79
LM748CN	.67
LM1310N	1.09
LM1458N	.62
LM1496N	1.16
LM1800N	1.21
LM1801N	1.79
LM1812N	6.12
LM1830N	1.66
LM1848N	3.16
LM1870N	3.47
LM1871N	3.37
LM1872N	3.37
LM1889N	2.40
LM2111N	1.54
LM2900N	1.15
LM2901N	.94
LM2902N	1.06
LM2903N	1.07
LM2904N	.87
LM2905N	3.04
LM2907N	2.56
LM2907N-8	2.32
LM2917N	2.09
LM2917N-8	2.07
LM2924N	1.70
LM3046N	.99
LM3080N	1.00
LM3086N	.79
LM3089N	1.70
LM3301N	.86
LM3302N	.66
LM3401N	.76
LM3524N	4.45
LM3900N	.86
LM3905N	1.45
LM3909N	.80
LM3911N	1.92
LM3914N	3.25
LM3915N	3.25
LM3916N	3.25
LM4250CN	1.47
LM7805CK	2.01
LM7812CK	2.01
LM7815CK	2.01
LM7805CT	1.24
LM7812CT	1.24
LM7815CT	1.24
LM78L05ACZ	.41
LM78L12ACZ	.41
LM78L15ACZ	.41
LM78L24ACZ	.41
LM7905CT	1.27
LM7906CT	1.27
LM7912CT	1.27
LM7915CT	1.27
LM7924CT	1.27
LM79L05ACZ	.96
LM79L12ACZ	.96
LM79L15ACZ	.96
LM13080N	1.55
LM13600N	2.04
MF10CN	6.00

★★★★★★★★★★★★★★★★★

4116 200 nsec 16,384x1 D Ram

Prime Parts As Low As $1.365 Each.

Part No.	8	32	128	512	1024
	Price Per Pak Of				
4116N-ND	15.12	57.12	215.00	806.40	1397.75
5290N-ND	15.12	57.12	215.00	806.40	1397.75
Price Each	1.89	1.785	1.68	1.575	1.365

NSC Data Books

Book Title	Part No.	Price
1982 Transistor Databook	9070B	$ 6.00
1981 Logic Databook	9054B	9.00
1982 Linear Databook	9068B	12.00
1981 CMOS Databook	9056B	6.00
1980 Interface Databook	9064B	6.00
NSC Databook Set (The 4 Above Books)	9066B	29.95
1978 Data Conversion/Acquisition Handbook	9050B	7.00
1980 Memory Book	9059B	6.00
1982 COPS Microcontroller Data Book	9069B	6.00
1979 Special Function Databook	9057B	6.00
NSC 800 Microprocessor Family Handbook-1981	9053B	5.00
Linear Applications Handbook	9062B	16.00
Microprocessor Applications In Business, Science and Industry	9055B	4.00
1980 Audio/Radio Handbook	9065B	5.00
Voltage Regulator Handbook-1982	9063B	7.00

MOLEX I.C. SOCKET PINS

1.25/C 11.25/M 52.50/5M 500.00/M

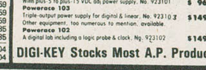
AP SUPER-STRIPS

UNIVERSAL BREADBOARDING ELEMENTS WITH SOLDERLESS PLUG-IN TIE POINTS

The A P Super-Strips combine a power signal distribution system with a matrix of 128 terminals, each with 5 tie points. The distribution system consists of eight buses, each individual bus consisting of a line of 25 tie points. All tie points are the solderless plug-in type of the same design used on A P terminal Strips and A P Distribution Strips.

923252 (Alloy 770 Terminals) $18.50
923748 (Gold-plated Terminals) $33.95

POWERACE



For faster and easier prototyping. They have built in power-supplies.

Powerace 101 With plus-5 to plus-15 VDC adj power supply. No. 923101 $ 96.95
Powerace 103 Triple-output power supply for digital & linear. No. 923103 $149.95
Other equipment, too numerous to mention, available.
Powerace 102 A digital lab including a logic probe & clock. No. 923102 $149.95

DIGI-KEY Stocks Most A.P. Products

TEXAS INSTRUMENTS I.C. SOCKETS

Body — 94 V-O polyester with Copper Alloy contacts. Accommodates standard IC leads up to .014" thick and .025" wide. Contact is designed and oriented to the insulator to grasp the broad "face" of the IC lead, allowing for low insertion and high retention forces. Socket is designed to achieve maximum density on boards.

SOLDER TAIL DIP SOCKETS

- ★ Single beam
- ★ Low profile
- ★ YOUR CHOICE: TIN OR GOLD* (Minimum .50 microinch gold inlay on gold sockets)

TIN PLATED SOLDER TAIL -40° to +75°C — Min. 200 Microinches Tin

Part No.	Description	1	10	100
C8908	8 pin solder tail, tin	.13	1.15	10.50
C8914	14 pin solder tail, tin	.15	1.45	12.00
C8916	16 pin solder tail, tin	.17	1.60	13.00
C8918	18 pin solder tail, tin	.20	1.90	17.00
C8920	20 pin solder tail, tin	.23	2.10	20.00
C8922	22 pin solder tail, tin	.25	2.25	21.00
C8924	24 pin solder tail, tin	.28	2.50	24.00
C8928	28 pin solder tail, tin	.32	2.90	27.00
C8940	40 pin solder tail, tin	.46	4.20	39.00

GOLD INLAY SOLDER TAIL -65° to +125°C — Min. 50 Microinches Gold

Part No.	Description	1	10	100
C9808	8 pin solder tail, gold	.34	3.20	30.00
C9814	14 pin solder tail, gold	.44	4.20	40.00
C9816	16 pin solder tail, gold	.50	4.70	45.00
C9818	18 pin solder tail, gold	.57	5.40	52.00
C9820	20 pin solder tail, gold	.63	5.90	57.00
C9822	22 pin solder tail, gold	.70	6.60	64.00
C9824	24 pin solder tail, gold	.76	7.20	70.00
C9828	28 pin solder tail, gold	.79	7.50	73.00
C9840	40 pin solder tail, gold	1.12	9.90	97.00

WIRE WRAP DIP SOCKETS

- ★ Standard profile
- ★ Universal mounting and packaging capabilities
- ★ Contacts accommodate .015" through .021" rectangular or round dual-in-line leads.
- ★ Wire wrap posts held to true position of .015" providing a true position of .020" on boards for efficient automatic wire wrapping
- ★ YOUR CHOICE: TIN OR GOLD* (Minimum .50 microinch gold inlay on gold sockets)
- ★ TEXAS INSTRUMENTS QUALITY

TIN PLATED WIRE WRAP — Min. 200 Microinches Tin

Part No.	Description	1	10	100
C8108	8 pin wire wrap, tin	.38	3.60	34.00
C8114	14 pin wire wrap, tin	.50	4.90	48.00
C8116	16 pin wire wrap, tin	.57	5.60	55.00
C8118	18 pin wire wrap, tin	.69	6.70	65.00
C8120	20 pin wire wrap, tin	.76	7.50	74.00
C8122	22 pin wire wrap, tin	.83	8.20	81.00
C8124	24 pin wire wrap, tin	.91	8.90	88.00
C8128	28 pin wire wrap, tin	1.04	10.30	102.00
C8140	40 pin wire wrap, tin	1.42	13.90	138.00

GOLD INLAY WIRE WRAP — Min. 50 Microinches Gold

Part No.	Description	1	10	100
C9108	8 pin wire wrap, gold	.59	5.80	57.00
C9114	14 pin wire wrap, gold	.79	7.80	77.00
C9116	16 pin wire wrap, gold	.85	8.40	83.00
C9118	18 pin wire wrap, gold	.99	9.80	97.00
C9120	20 pin wire wrap, gold	1.19	11.80	117.00
C9122	22 pin wire wrap, gold	1.29	12.80	127.00
C9124	24 pin wire wrap, gold	1.39	13.80	137.00
C9128	28 pin wire wrap, gold	1.69	16.80	167.00
C9140	40 pin wire wrap, gold	2.29	22.80	227.00

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

RELIABLE, COST-EFFICIENT CONTACT DESIGN

- 50 (Wire Wrap) to 50 (solder Tail) micro-inches gold inlay over a nickel diffusion barrier.
- Copper-nickel-tin CA 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

NOTE — Dimensions below are the pin center to center measurement followed by the distance separating the two pin rows.

H4 SERIES .100"x.200" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Wire Wrap	1	10	Part No. Solder Tail	1	10
10/20	C6-10	3.85	37.60	C5-10	2.95	28.00
15/30	C6-15	4.50	43.40	C5-15	3.40	32.50
17/34	C6-17	4.70	45.80	C5-17	3.60	34.30
18/36	C6-18	4.60	44.40	C5-18	3.55	33.90
20/40	C6-20	5.30	49.30	C5-20	3.90	37.40
22/44	C6-22	5.60	53.50	C5-22	4.20	40.40
25/50	C6-25	5.95	57.90	C5-25	4.50	43.30
28/56	C6-28	6.30	61.40	C5-28	4.80	46.00
30/60	C6-30	6.40	62.60	C5-30	4.95	48.20
31/62	C6-31	6.70	65.70	C5-31	5.20	49.35
35/70	C6-35	7.80	76.30	C5-35	5.80	56.10
36/72	C6-36	7.50	73.60	C5-36	5.70	55.50
40/80	C6-40	8.60	84.10	C5-40	6.30	61.70
43/86	C6-43	9.30	90.20	C5-43	6.80	65.60
49/98	C6-49	10.60	104.60	C5-49	7.80	76.80
50/100	C6-50	9.90	98.30	C5-50	7.40	72.10

For Polarizing Keys Order P/N CR1164-2 .... $ .10/ea., $7.50/100

H4 SERIES .125" x .250" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Wire Wrap	1	10	Part No. Solder Tail	1	10
10/20	C4-10	4.35	42.20	C3-10	2.95	28.40
15/30	C4-15	5.20	49.50	C3-15	3.40	33.40
18/36	C4-18	5.50	53.30	C3-18	3.70	35.90
20/40	C4-20	5.90	57.10	C3-20	3.95	38.70
22/44	C4-22	6.20	59.10	C3-22	4.20	40.90
25/50	C4-25	6.60	64.30	C3-25	4.70	45.70
28/56	C4-28	6.70	65.70	C3-28	4.85	47.40
30/60	C4-30	6.90	67.70	C3-30	4.95	48.60
31/62	C4-31	7.30	70.60	C3-31	5.25	51.70
35/70	C4-35	8.30	80.60	C3-35	6.10	59.10
36/72	C4-36	8.35	80.70	C3-36	6.10	59.10
40/80	C4-40	8.90	87.10	C3-40	6.55	64.20
44/88	C4-44	9.95	98.90	C3-44	7.40	72.50
50/100	C4-50	10.90	107.50	C3-50	7.90	77.90

For Polarizing Keys Order P/N CR1164-2 .... $ .10/ea., $7.50/100

H4 SERIES .156" x .200" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Solder Tail	1	10	Part No. Solder Eye	1	10
10/20	C1-10	2.55	23.80	C2-10	4.11	38.36
12/24	C1-12	2.90	27.50			
15/30	C1-15	3.03	28.28	C2-15	4.77	44.52
18/36	C1-18	3.27	30.52	C2-18	5.07	47.82
22/44	C1-22	3.69	34.44			
25/50	C1-25	4.25	40.40	C2-25	6.18	57.68
28/56	C1-28	4.47	41.72			

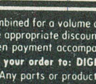
For Polarizing Keys Order P/N CR1164-1 .... $ .10/ea., $7.50/100

ELECTRONIC HARDWARE KIT

1600 pieces of zinc plated hardware complete with divided plastic box for easy storage

ELECTRONIC HARDWARE KIT CONTAINS:

100 2-56x1/4 Machine Screws
100 2-56x1/2 Machine Screws
100 4-40x1/4 Machine Screws
100 4-40x1/2 Machine Screws
100 6-32x1/4 Machine Screws
100 6-32x1/2 Machine Screws
100 8-32x1/2 Machine Screws
100 8-32x5/8 Machine Screws
100 2-56 Hex Nuts
100 4-40 Hex Nuts
100 6-32 Hex Nuts
100 8-32 Hex Nuts
100 No. 2 Internal Tooth Lock Washers
100 No. 4 Internal Tooth Lock Washers
100 No. 6 Internal Tooth Lock Washers
100 No. 8 Internal Tooth Lock Washers



CAT. NO. 1600 KIT **$14.95**

PANASONIC ELECTROLYTIC KIT

150 CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 15 POPULAR CAPACITORS

Cat. No. P6200-Kit *ONLY* **$35.95**

Panasonic LS Series

Miniature Aluminum Electrolytic Capacitors

Value UF	WV D.C.	Axial 1	Axial 10	Axial 100	Radial 1	Radial 10	Radial 100
22	/6.3	.18	1.54	12.83	—	—	—
33	/6.3	.20	1.68	14.04	.14	1.12	9.31
47	/6.3	.21	1.74	14.48	.14	1.16	9.59
100	/6.3	.22	1.83	15.22	.16	1.33	11.05
220	/6.3	.28	2.34	19.53	.21	1.78	14.80
330	/6.3	.29	2.46	20.48	.23	1.92	15.95
470	/6.3	.33	2.78	23.15	.23	1.97	16.34
1000	/6.3	.49	4.20	35.00	.36	3.08	25.62
2200	/6.3	.60	5.13	42.75	.54	4.56	37.95
3300	/6.3	.81	6.94	57.83	.75	6.38	53.10
4700	/6.3	1.04	8.89	74.07	.93	7.95	66.20
6800	/6.3	1.27	10.87	90.58	1.13	9.68	80.62
10000	/6.3	1.54	13.17	109.77	1.54	13.13	109.40
22	/10	.18	1.54	12.83	.13	1.08	8.94
33	/10	.21	1.74	14.48	.14	1.16	9.59
47	/10	.21	1.77	14.78	.14	1.19	9.90
100	/10	.24	2.00	16.65	.17	1.39	11.58
220	/10	.29	2.46	20.48	.23	1.92	15.95
330	/10	.33	2.78	23.15	.24	2.06	17.10
470	/10	.44	3.72	30.97	.35	2.97	24.69
1000	/10	.55	4.63	38.62	.41	3.42	28.45
2200	/10	.78	6.63	55.28	.70	5.93	49.42
3300	/10	.99	8.45	70.38	.90	7.71	64.22
4700	/10	1.28	10.94	91.18	1.13	9.68	80.62
6800	/10	1.55	13.26	110.52	1.54	13.20	109.40
10000	/10	1.99	17.00	141.63	—	—	—
10	/16	.18	1.54	12.83	.13	1.08	8.94
22	/16	.21	1.74	14.48	.14	1.15	9.52
33	/16	.21	1.77	14.77	.14	1.19	9.90
47	/16	.24	2.00	16.65	.16	1.36	11.31
100	/16	.28	2.34	19.53	.21	1.78	14.80
220	/16	.33	2.78	23.15	.24	2.06	17.10
330	/16	.44	3.72	30.97	.35	2.97	24.69
470	/16	.50	4.22	35.14	.38	3.19	26.58
1000	/16	.60	5.09	42.45	.50	4.21	35.08
2200	/16	.92	7.85	65.39	.87	7.46	62.10
3300	/16	1.16	9.91	82.62	1.17	10.01	83.48
4700	/16	1.57	13.40	111.68	1.57	13.43	111.87
6800	/16	1.99	17.00	141.63	—	—	—
2.2	/25	.18	1.54	12.83	—	—	—
3.3	/25	.18	1.54	12.83	.13	1.08	8.94
4.7	/25	.18	1.54	12.83	.13	1.08	8.94
10	/25	.18	1.54	12.83	.14	1.15	9.52
22	/25	.22	1.83	15.22	.15	1.22	10.17
33	/25	.24	2.00	16.65	.17	1.38	11.50
47	/25	.28	2.34	19.53	.21	1.73	14.42
100	/25	.33	2.78	23.15	.23	1.90	15.77
220	/25	.44	3.75	31.24	.40	3.42	28.45
330	/25	.50	4.26	35.47	.52	4.45	37.08
470	/25	.58	4.95	41.24	.64	5.42	45.13
1000	/25	.84	7.18	59.84	.83	7.06	58.78
2200	/25	1.16	9.91	82.62	1.17	10.02	83.47
3300	/25	1.61	13.77	114.77	1.66	14.17	118.03
4700	/25	1.99	17.00	141.63	—	—	—
2.2	/35	.18	1.54	12.83	—	—	—
3.3	/35	.18	1.54	12.83	.13	1.11	9.20
4.7	/35	.18	1.54	12.83	.13	1.11	9.20
10	/35	.21	1.77	14.78	.14	1.19	9.90
22	/35	.24	2.00	16.65	.19	1.60	13.30
33	/35	.28	2.34	19.53	.21	1.78	14.80
47	/35	.33	2.78	23.15	.23	1.90	15.77
100	/35	.43	3.65	30.40	.24	2.06	17.10
220	/35	.51	4.34	36.17	.40	3.42	28.45
330	/35	.57	4.85	40.40	.52	4.45	37.08
470	/35	.65	5.51	45.89	.64	5.42	45.13
1000	/35	.98	8.38	69.80	.92	7.84	65.32
2200	/35	1.61	13.77	114.71	1.66	14.17	118.03
3300	/35	1.99	17.00	141.63	—	—	—
4700	/35	2.61	22.31	185.88	—	—	—
0.47	/50	.18	1.54	12.83	.13	1.08	8.94
1	/50	.18	1.54	12.83	.13	1.08	8.94
1	/50	.18	1.54	12.83	.13	1.08	8.94
2.2	/50	.18	1.54	12.83	.13	1.08	8.94
3.3	/50	.18	1.54	12.83	.14	1.15	9.52
4.7	/50	.21	1.77	14.77	.14	1.18	9.78
10	/50	.24	2.00	16.65	.16	1.35	11.20
22	/50	.28	2.34	19.53	.22	1.83	15.19
33	/50	.32	2.69	27.43	.23	1.90	15.77
47	/50	.36	3.04	25.33	.24	2.05	17.03
100	/50	.45	3.78	31.54	.36	3.08	25.62
220	/50	.61	5.18	43.15	.52	4.45	37.08
330	/50	.76	6.50	54.14	.83	7.06	58.78
470	/50	.92	7.87	65.55	.92	7.84	65.32
1000	/50	1.25	10.71	89.27	1.31	11.16	92.93
2200	/50	1.99	17.00	141.63	—	—	—
0.47	/63	.18	1.54	12.83	.13	1.12	9.32
1	/63	.18	1.54	12.83	.13	1.12	9.32
2.2	/63	.18	1.54	12.83	.14	1.15	9.52
3.3	/63	.21	1.77	14.77	.15	1.25	10.35
4.7	/63	.24	2.00	16.65	.16	1.34	11.13
10	/63	.28	2.34	19.53	.18	1.50	12.43
22	/63	.33	2.78	23.15	.24	2.02	16.79
33	/63	.37	3.12	26.04	.27	2.24	18.60
47	/63	.53	4.51	37.62	.38	3.18	26.45
100	/63	.56	4.76	39.64	.50	4.24	35.27
220	/63	.76	6.50	54.14	.78	6.61	55.02
330	/63	.92	7.87	65.55	.92	7.84	65.32
470	/63	1.05	8.94	74.52	.99	8.43	70.19
1000	/63	1.64	13.99	116.55	1.66	14.17	118.03
2200	/63	2.61	22.31	185.89	—	—	—
0.47	/100	.18	1.54	12.83	.14	1.19	9.90
1	/100	.18	1.54	12.83	.14	1.19	9.90
2.2	/100	.22	1.83	15.22	.15	1.25	10.35
3.3	/100	.24	2.00	16.65	.17	1.38	11.50
4.7	/100	.28	2.34	19.53	.17	1.41	11.70
10	/100	.33	2.78	23.15	.22	1.83	15.19
22	/100	.43	3.65	30.40	.27	2.27	18.90
33	/100	.45	3.85	32.12	.34	2.88	24.00
47	/100	.54	4.62	38.49	.41	3.50	29.14
100	/100	.74	6.29	52.43	.57	4.83	40.22
220	/100	1.09	9.26	77.18	.96	8.22	68.47
330	/100	1.30	11.10	92.53	1.25	10.70	89.13
470	/100	1.81	15.46	128.80	1.78	15.25	127.04
1000	/100	3.16	27.09	225.72	—	—	—

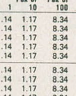
PANASONIC POLYESTER CAPACITORS

100 VDC plus minus 10% TOLERANCE

NEW! KIT 150 POLYESTER CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY



CAT. NO. M-KIT *ONLY* **$34.95**

Part No.	Cap. (UFD)	1	Pak of 10	Pak of 100	Pak of 1,000
M1102	.001	.14	1.17	8.34	75.04
M1122	.0012	.14	1.17	8.34	75.04
M1152	.0015	.14	1.17	8.34	75.04
M1182	.0018	.14	1.17	8.34	75.04
M1222	.0022	.14	1.17	8.34	75.04
M1272	.0027	.14	1.17	8.34	75.04
M1332	.0033	.14	1.17	8.34	75.04
M1392	.0039	.14	1.17	8.34	75.04
M1472	.0047	.14	1.17	8.34	75.04
M1562	.0056	.14	1.17	8.34	75.04
M1682	.0068	.14	1.17	8.34	75.04
M1822	.0082	.14	1.17	8.34	75.04
M1103	.01	.14	1.17	8.34	75.04
M1123	.012	.14	1.22	8.65	77.85
M1153	.015	.14	1.22	8.65	77.85
M1183	.018	.15	1.24	8.80	79.20
M1223	.022	.15	1.26	8.94	80.44
M1273	.027	.15	1.26	8.94	80.44
M1333	.033	.15	1.28	9.10	81.80
M1393	.039	.16	1.32	9.40	84.60
M1473	.047	.16	1.35	9.60	86.18
M1563	.056	.17	1.46	10.38	93.38
M1683	.068	.18	1.51	10.74	96.64
M1823	.082	.18	1.55	11.07	99.57
M1104	.1	.19	1.58	12.28	101.48
M1124	.12	.21	1.80	12.85	115.65
M1154	.15	.23	2.01	14.30	128.70
M1184	.18	.26	2.26	16.09	144.79
M1224	.22	.28	2.38	16.98	152.78
M1274	.27	.32	2.72	19.40	174.60
M1334	.33	.34	2.96	21.12	190.02
M1394	.39	.39	3.35	23.88	214.88
M1474	.47	.41	3.58	25.57	230.07

E. F. JOHNSON SPACER KIT

100 COMPONENTS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 100 POPULAR ALUMINUM SPACERS

Cat. No. J200-Kit *ONLY* **$29.95**

DISC CAPACITORS

Panasonic Ceramic Disc Capacitors

NEW! KIT 310 DISC CAPACITORS

Prices include convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 18 POPULAR VALUES PANASONIC QUALITY

CAT. NO. DH-KIT *ONLY* **$24.95**

DIGI-KEY now has an expanded line of Panasonic Ceramic Disc Capacitors, including (listed after NPO banner)

NPO TYPE

For Complete Specs on Physical Size and Electrical Characteristics, consult your *FREE* DIGI-KEY Catalog.

Part No.	Cap.	Volt.	10	100	1,000
			Price		
P4000	10 pf	500	.75	6.49	48.71
P4002	15 pf	500	.75	6.49	48.71
P4003	18 pf	500	.75	6.49	48.71
P4004	22 pf	500	.75	6.49	48.71
P4005	27 pf	500	.75	6.49	48.71
P4006	33 pf	500	.75	6.49	48.71
P4007	39 pf	500	.75	6.49	48.71
P4008	47 pf	500	.75	6.49	48.71
P4009	56 pf	500	.75	6.49	48.71
P4010	68 pf	500	.84	7.23	54.22
P4011	82 pf	500	.84	7.23	54.22
P4100	100 pf	500	.63	5.43	40.72
P4102	150 pf	500	.63	5.43	40.72
P4103	180 pf	500	.63	5.43	40.72
P4104	220 pf	500	.63	5.43	40.72
P4105	270 pf	500	.63	5.43	40.72
P4106	330 pf	500	.63	5.43	40.72
P4107	390 pf	500	.63	5.43	40.72
P4108	470 pf	500	.80	6.91	51.86
P4109	560 pf	500	.80	6.91	51.86
P4110	680 pf	500	.80	6.91	51.86
P4111	820 pf	500	.80	6.91	51.86
P4112	1000 pf	500	1.00	8.58	64.35
P4114	1500 pf	500	1.00	8.58	64.35
P4115	1800 pf	500	1.31	11.25	84.37
P4200	1000 pf	100	.58	5.01	37.57
P4202	1500 pf	100	.58	5.01	37.57
P4203	2200 pf	100	.58	5.01	37.57
P4205	3300 pf	100	.58	5.01	37.57
P4206	4700 pf	100	.58	5.01	37.57
P4209	6800 pf	100	.70	6.00	45.00
P4300	.01 uf	25	.56	4.83	36.23
P4303	.022 uf	25	.68	5.91	44.32
P4305	.033 uf	25	.82	7.08	53.10
P4307	.047 uf	25	.89	7.68	57.60
P4311	.1 uf	25	1.79	15.37	115.31

NPO NPO NPO NPO NPO NPO NPO NPO

Part No.	Cap.	Volt.	10	100	1,000
P4400	10 pf	500	.73	6.28	47.13
P4402	15 pf	500	.81	6.97	52.31
P4403	18 pf	500	.81	6.97	52.31
P4404	22 pf	500	.81	6.97	52.31
P4405	27 pf	500	.81	6.97	52.31
P4406	33 pf	500	1.03	8.89	66.71
P4407	39 pf	500	1.03	8.89	66.71
P4408	47 pf	500	1.37	11.80	88.53
P4409	56 pf	500	1.37	11.80	88.53
P4410	68 pf	500	1.56	13.38	100.35
P4411	82 pf	500	2.05	17.59	131.96

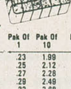
See The DIGI-KEY Catalog For Low OEM Prices On Disc Capacitors

PANASONIC METALLIZED POLYESTER CAPACITORS

NEW! KIT 170 METALLIZED POLYESTER CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY



CAT. NO. E-KIT *ONLY* **$54.95**

DIGI-KEY Part No.	Working Voltage	µF	Pak Of 1	Pak Of 10	Pak Of 100	Pak Of 1,000
E1104	100	.1	.23	1.99	16.53	148.73
E1124	100	.12	.25	2.12	17.63	158.73
E1154	100	.15	.27	2.28	18.95	170.55
E1184	100	.18	.29	2.49	20.73	186.53
E1224	100	.22	.32	2.68	22.27	200.37
E1274	100	.27	.34	2.91	24.25	218.25
E1334	100	.33	.37	3.18	26.45	238.05
E1394	100	.39	.41	3.44	28.65	257.85
E1474	100	.47	.43	3.68	30.65	275.85
E1564	100	.56	.47	4.02	33.45	301.05
E1684	100	.68	.52	4.44	36.93	332.35
E1824	100	.82	.58	4.94	41.13	370.13
E1105	100	1.0	.63	5.35	44.52	400.62
E1125	100	1.2	.68	5.82	48.50	436.50
E1155	100	1.5	.86	7.32	60.97	548.67
E1185	100	1.8	1.01	8.64	71.99	647.89
E1225	100	2.2	1.04	8.85	73.70	663.08
E1275	100	2.7	1.04	8.85	73.70	663.08
E1335	100	3.3	1.35	11.50	95.85	862.54
E1395	100	3.9	1.35	11.50	95.85	862.54
E1475	100	4.7	1.75	14.95	124.55	1120.73
E1565	100	5.6	1.95	16.65	138.70	1248.08
E1685	100	6.8	2.35	20.14	167.85	1510.43
E1825	100	8.2	2.86	24.45	203.70	1833.30
E1106	100	10.0	3.23	27.69	230.75	2076.41
E2103	250	.01	.19	1.64	13.68	123.08
E2123	250	.012	.19	1.64	13.68	123.08
E2153	250	.015	.19	1.64	13.68	123.08
E2183	250	.018	.19	1.64	13.68	123.08
E2223	250	.022	.19	1.64	13.68	123.08
E2273	250	.027	.19	1.64	13.68	123.08
E2333	250	.033	.19	1.64	13.68	123.08
E2393	250	.039	.19	1.64	13.68	123.08
E2473	250	.047	.19	1.64	13.68	123.08
E2563	250	.056	.22	1.85	15.43	138.83
E2683	250	.068	.22	1.85	15.43	138.83
E2823	250	.082	.22	1.85	15.43	138.83
E2104	250	.10	.23	1.94	16.13	145.13
E2124	250	.12	.25	2.12	17.63	158.63
E2154	250	.15	.27	2.28	18.95	170.55
E2184	250	.18	.29	2.49	20.73	186.53
E2224	250	.22	.32	2.68	22.28	200.48
E2274	250	.27	.34	2.91	24.25	218.25
E2334	250	.33	.37	3.18	26.47	238.17
E2394	250	.39	.41	3.44	28.65	257.85
E2474	250	.47	.43	3.68	30.65	275.85
E2564	250	.56	.47	4.02	33.45	301.05
E2684	250	.68	.52	4.43	36.93	332.33
E2824	250	.82	.58	4.94	41.13	370.13
E2105	250	1.0	.63	5.35	44.52	400.62
E2125	250	1.2	.68	5.82	48.50	436.50
E2155	250	1.5	.86	7.32	60.97	548.67
E2185	250	1.8	1.01	8.64	72.00	648.00
E2225	250	2.2	1.03	8.85	73.68	663.08
E4103	400	.01	.34	2.93	24.40	219.15
E4123	400	.012	.34	2.93	24.40	219.15
E4153	400	.015	.34	2.93	24.40	219.15
E4183	400	.018	.34	2.93	24.40	219.15
E4223	400	.022	.34	2.93	24.40	219.15
E4273	400	.027	.34	2.93	24.40	219.15
E4333	400	.033	.34	2.93	24.40	219.15
E4393	400	.039	.34	2.93	24.40	219.15
E4473	400	.047	.34	2.93	24.40	219.15
E4563	400	.056	.34	2.93	24.40	219.15
E4683	400	.068	.34	2.93	24.40	219.15
E4823	400	.082	.44	3.76	31.28	281.48
E4104	400	.10	.45	3.83	31.92	287.21
E4124	400	.12	.47	4.04	33.60	302.40
E4154	400	.15	.49	4.18	34.80	313.20
E4184	400	.18	.55	4.68	38.98	350.78
E4224	400	.22	.57	4.89	40.73	366.53
E4274	400	.27	.69	5.85	48.73	438.53
E4334	400	.33	.75	6.38	53.15	478.35
E4394	400	.39	.82	7.02	58.48	526.28
E4474	400	.47	.91	7.78	64.80	583.20
E4564	400	.56	1.07	9.14	76.12	685.00
E4684	400	.68	1.21	10.37	86.42	777.75
E4824	400	.82	1.29	11.03	91.90	826.99
E4105	400	1.0	1.35	11.50	95.83	862.43
E4125	400	1.2	1.47	12.60	105.00	945.00
E4155	400	1.5	1.59	13.56	112.98	1016.80
E4185	400	1.8	1.88	16.10	134.13	1207.15
E4225	400	2.2	2.15	18.34	152.95	1376.55

PLESSEY "MINI-BOX"

Metalized Poly. Cap. Kit

140 CAPACITORS

Price includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 14 POPULAR "MINI-BOX" CAPACITORS

CAT. NO. 3050P-Kit *ONLY* **$35.95**

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

NEW! KIT 180 TANTALUM CAPACITORS

Prices includes convenient divided plastic box with bin guide for easy storage and quick access.

ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY

CAT. NO. F-KIT *ONLY* **$79.95**

Digi-Key Part No.*	CAP (µF)	Voltage Volt DC	1	10	100	1000
			Price			
P2000	3.3	3.15	.38	3.21	26.70	240.30
P2001	6.8	3.15	.38	3.21	26.70	240.30
P2002	10	3.15	.41	3.47	28.85	259.65
P2003	15	3.15	.46	3.88	32.32	290.81
P2004	22	3.15	.53	4.47	37.23	335.02
P2005	33	3.15	.63	5.40	45.00	405.00
P2006	47	3.15	.77	6.61	55.05	495.45
P2007	68	3.15	.98	8.35	69.54	625.83
P2008	100	3.15	1.29	11.04	91.97	827.77
P2009	150	3.15	2.54	21.90	182.37	1541.27
P2010	220	3.15	3.31	28.35	236.25	2126.25
P2011	4.7	6	.38	3.21	26.70	240.30
P2012	6.8	6	.44	3.78	31.44	282.94
P2013	10	6	.51	4.32	35.94	323.44
P2014	15	6	.64	5.42	45.14	406.24
P2015	22	6	.74	6.34	52.78	474.98
P2016	33	6	.96	8.19	68.24	614.13
P2017	47	6	1.23	10.54	87.84	790.53
P2018	68	6	1.64	14.05	117.04	1053.33
P2019	100	6	2.54	21.90	182.37	1641.27
P2020	150	6	3.31	28.35	236.25	2126.25
P2021	1.0	10	.38	3.21	26.70	240.30
P2022	2.2	10	.38	3.21	26.70	240.30
P2023	3.3	10	.38	3.21	26.70	240.30
P2024	4.7	10	.46	3.88	32.32	290.82
P2025	6.8	10	.52	4.43	36.88	331.87
P2026	10	10	.62	5.30	44.14	397.23
P2027	15	10	.78	6.65	55.38	498.38
P2028	22	10	.99	8.49	70.75	636.75
P2029	33	10	1.34	11.43	95.25	857.25
P2030	47	10	1.77	15.18	126.44	1137.93
P2031	68	10	2.54	21.90	182.37	1641.27
P2032	100	10	3.31	28.35	236.25	2126.25
P2033	1.5	16	.38	3.21	26.70	240.30
P2034	2.2	16	.42	3.56	29.63	266.63
P2035	3.3	16	.47	4.02	33.43	300.83
P2036	4.7	16	.55	4.65	38.70	348.30
P2037	6.8	16	.65	5.54	46.14	415.24
P2038	10	16	.81	6.91	57.53	517.73
P2039	15	16	1.06	9.06	75.50	679.50
P2040	22	16	1.41	12.05	100.37	903.27
P2041	33	16	1.89	16.18	134.83	1213.43
P2042	47	16	2.54	21.90	182.37	1641.27
P2043	68	16	3.31	28.35	236.25	2126.25
P2044	1.5	25	.43	3.64	30.33	272.93
P2045	2.2	25	.48	4.08	33.95	305.55
P2046	3.3	25	.57	4.85	40.35	363.15
P2047	4.7	25	.68	5.78	48.12	433.02
P2048	6.8	25	.84	7.17	59.69	537.19
P2049	10	25	1.09	9.30	77.48	697.28
P2050	15	25	1.48	12.65	105.38	948.38
P2051	22	25	2.54	21.90	182.37	1641.27
P2052	33	25	3.31	28.35	236.25	2126.25
P2053	0.1	35	.38	3.21	26.70	240.30
P2054	0.15	35	.38	3.21	26.70	240.30
P2055	0.22	35	.38	3.21	26.70	240.30
P2056	0.33	35	.38	3.21	26.70	240.30
P2057	0.47	35	.38	3.21	26.70	240.30
P2058	0.68	35	.38	3.21	26.70	240.30
P2059	1.0	35	.39	3.33	27.82	250.32
P2060	1.5	35	.48	4.06	33.78	303.98
P2061	2.2	35	.55	4.67	38.88	349.88
P2062	3.3	35	.67	5.74	47.77	429.87
P2063	4.7	35	.83	7.04	58.65	527.85
P2064	6.8	35	1.05	8.98	74.79	673.09
P2065	10	35	1.40	11.97	99.75	897.75
P2066	15	35	3.31	28.35	236.25	2126.25
P2067	0.1	50	.40	3.40	28.33	254.93
P2068	0.15	50	.40	3.40	28.33	254.93
P2069	0.22	50	.40	3.40	28.33	254.93
P2070	0.33	50	.40	3.40	28.33	254.93
P2071	0.47	50	.40	3.40	28.33	254.93
P2072	0.68	50	.45	3.82	31.80	286.20
P2073	1.0	50	.59	4.99	41.55	373.95
P2074	1.5	50	.63	5.40	45.00	405.00
P2075	2.2	50	.80	6.84	57.00	513.00
P2076	3.3	50	1.07	9.15	76.19	685.69
P2077	4.7	50	2.27	19.40	161.60	1454.40
P2078	6.8	50	3.31	28.35	236.25	2126.25

TANTALUM SUBSTITUTES PANASONIC K-SERIES CAPACITORS

New Panasonic K-Series are miniature, low cost aluminum electrolytic capacitors. Their size and performance characteristics make them viable alternatives to tantalums in many applications.

CAPACITANCE TOLERANCE: 20%
D.C. LEAKAGE CURRENT, MAX. 0.01 C V or 3uA
All K-SERIES CAPACITORS We Carry Are Radial

DIGI-KEY Part No.	Cap. UF	Working Voltage DC	1	10 Pak	100 Pak	1000 Pak
P800	22		.24	2.03	16.85	151.65
P801	33	6.3	.25	2.13	17.70	159.19
P802	47		.26	2.18	18.15	163.24
P803	100		.30	2.56	21.35	191.81
P804	22		.25	2.13	17.70	159.19
P805	33	10	.26	2.23	18.55	166.73
P806	47		.28	2.37	19.85	178.31
P807	10		.25	2.07	17.25	155.25
P808	22	16	.27	2.28	19.00	170.78
P809	33		.29	2.45	20.35	183.15
P810	47		.32	2.72	22.60	203.40
P811	3.3		.24	2.03	16.85	151.65
P812	4.7		.24	2.03	16.85	151.65
P813	10	25	.25	2.13	17.70	159.20
P814	22		.29	2.45	20.35	183.15
P815	33		.33	2.76	23.00	207.00
P816	3.3		.24	2.03	16.85	151.65
P817	4.7	35	.25	2.07	17.25	155.25
P818	10		.26	2.23	18.55	166.75
P819	22		.32	2.23	22.60	203.40
P820	.1		.24	2.03	16.85	151.65
P821	.22		.24	2.03	16.85	151.65
P822	.33		.24	2.03	16.85	151.65
P823	.47		.24	2.03	16.85	151.65
P824	1.0	50	.24	2.03	16.85	151.65
P825	2.2		.24	2.03	16.85	151.65
P826	3.3		.25	2.07	17.25	155.25
P827	4.7		.25	2.13	17.70	159.20
P828	10		.28	2.38	19.85	178.31

Panasonic TSW Series

Large Aluminum Electrolytic Capacitors

DIGI-KEY Part No.	Working Voltage (W.V.)	Cap. (µF)	1	10	100
			Prices		
P6500	16	3300	$1.42	$10.94	$ 98.46
P6501		4700	1.70	13.08	117.78
P6502		6800	2.25	17.32	155.90
P6503		10000	2.82	21.76	195.88
P6504		15000	4.03	31.00	279.00
P6505	25	2200	1.45	11.20	100.84
P6506		3300	1.78	13.70	123.34
P6507		4700	2.23	17.17	154.59
P6508		6800	2.94	22.61	203.55
P6509		10000	3.79	29.17	262.59
P6510		15000	4.87	37.53	337.77
P6511	35	1000	1.21	9.35	84.17
P6512		2200	1.63	12.56	113.04
P6513		3300	2.19	16.88	151.94
P6514		4700	2.81	21.64	194.82
P6515		6800	3.61	27.79	250.15
P6516		10000	4.63	35.61	320.55
P6517	50	1000	1.47	11.35	102.17
P6518		2200	2.26	17.44	156.96
P6519		3300	3.12	24.03	216.17
P6520		4700	4.06	31.29	281.65
P6521		6800	4.95	38.08	342.78
P6522	100	470	1.70	13.11	118.05
P6523		1000	2.87	22.08	198.78
P6524		2200	4.60	35.44	318.96
P6525	200	220	2.24	17.29	155.65
P6526		330	2.88	22.20	199.84
P6527		470	3.96	30.47	274.23
P6528	250	150	2.58	19.86	178.75
P6529		220	3.05	23.53	211.77
P6530		330	3.55	27.35	246.17
P6531		470	4.58	35.29	317.65

The Digi-Key volume discount and Service charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when payment accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

You may pay by check, money order, Master Charge, VISA or C.O.D. ***DIGI-KEY GUARANTEE:*** Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice.

SERVICE CHARGES		VOLUME DISCOUNT	
$ 0.00-$ 9.99	Add $2.00	$ 0.00-$ 99.99	NET
$ 10.00-$25.00	Add $0.75	$ 100.00-$249.99	Less 10%
$ 25.00-$49.99	Add $0.50	$ 250.00-$499.99	Less 15%
$ 50.00-$99.99	Add $0.25	$ 500.00-$999.99	Less 20%
$100.00 & Up	No Charge	$1000.00 & Up	Less 25%

CIRCLE 39 ON FREE INFORMATION CARD

DIGI-KEY CORPORATION 800-346-5144

In Mn., Ak., Hi. Call 218-681-6674

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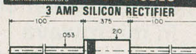
ITT Semiconductors — SILICON RECTIFIERS ZENER DIODES

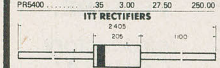
3 AMP SILICON RECTIFIER



IF	PIV	Surge (10ms)	VF
3A	50V	100A	1.1V

Part No.	1	10	100	1000
PR5400	.35	3.00	27.50	250.00

ITT RECTIFIERS



Cat. No.	Description	Pkg.	10	100	1000	10,000
1N4001	1 Amp 50 PIV	DO-41	.80	7.00	60.00	540.00
1N4002	1 Amp 100 PIV	DO-41	.80	7.00	60.00	540.00
1N4003	1 Amp 200 PIV	DO-41	.80	7.50	64.00	576.00
1N4004	1 Amp 400 PIV	DO-41	.80	7.90	68.00	612.00
1N4005	1 Amp 600 PIV	DO-41	1.00	9.00	74.00	666.00
1N4006	1 Amp 800 PIV	DO-41	1.00	9.00	80.00	720.00
1N4007	1 Amp 1000 PIV	DO-41	1.50	12.00	100.00	900.00
1N4148	Ultra Fast Switching Diode (1N914 equiv.)	DO-41	.60	5.00	32.00	276.60

ITT SILICON ZENER DIODES

Catalog Number	Description	Unit Price	10
1N5226B	3.3 V 5% 500mW Zener (1N746A equiv.)	.24	1.80
1N5227B	3.6 V 5% 500mW Zener (1N747A equiv.)	.24	1.80
1N5228B	3.9 V 5% 500mW Zener (1N748A equiv.)	.24	1.80
1N5229B	4.3 V 5% 500mW Zener (1N749A equiv.)	.24	1.80
1N5230B	4.7 V 5% 500mW Zener (1N750A equiv.)	.24	1.80
1N5231B	5.1 V 5% 500mW Zener (1N751A equiv.)	.24	1.80
1N5232B	5.6 V 5% 500mW Zener (1N752A equiv.)	.24	1.80
1N5233B	6.0 V 5% 500mW Zener	.24	1.80
1N5234B	6.2 V 5% 500mW Zener (1N753A equiv.)	.24	1.80
1N5235B	6.8 V 5% 500mW Zener (1N957B equiv.)	.24	1.80
1N5236B	7.5 V 5% 500mW Zener (1N958B equiv.)	.24	1.80
1N5237B	8.2 V 5% 500mW Zener (1N959B equiv.)	.24	1.80
1N5238B	8.7 V 5% 500mW Zener	.24	1.80
1N5239B	9.1 V 5% 500mW Zener (1N960B equiv.)	.24	1.80
1N5240B	10 V 5% 500mW Zener (1N961B equiv.)	.24	1.80
1N5241B	11 V 5% 500mW Zener (1N962B equiv.)	.24	1.80
1N5242B	12 V 5% 500mW Zener (1N963B equiv.)	.24	1.80
1N5243B	13 V 5% 500mW Zener (1N964B equiv.)	.24	1.80
1N5244B	14 V 5% 500mW Zener	.24	1.80
1N5245B	15 V 5% 500mW Zener (1N965B equiv.)	.24	1.80
1N5246B	16 V 5% 500mW Zener (1N966B equiv.)	.24	1.80
1N5247B	17 V 5% 500mW Zener	.24	1.80
1N5248B	18 V 5% 500mW Zener (1N967B equiv.)	.24	1.80
1N5249B	19 V 5% 500mW Zener	.24	1.80
1N5250B	20 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N972B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N973B equiv.)	.24	1.80

Littlefuse Fuses

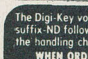
3AG "NORMAL-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	5	100	1,000
F100-ND	.010	13.70	206.00	926.00/M
F101-ND	.031	11.00	165.00	741.00/M
F102-ND	.062	4.00	60.00	270.00/M
F103-ND	.100	4.00	60.00	270.00/M
F104-ND	.125	4.00	60.00	270.00/M
F105-ND	.150	4.00	60.00	270.00/M
F106-ND	.175	4.00	60.00	270.00/M
F107-ND	.187	4.00	60.00	270.00/M
F108-ND	.200	4.00	60.00	270.00/M
F109-ND	.250	2.42	36.30	163.00/M
F110-ND	.300	2.42	36.30	163.00/M
F111-ND	.375	2.42	36.30	163.00/M
F112-ND	.500	2.42	36.30	163.00/M
F113-ND	.600	2.42	36.30	163.00/M
F114-ND	.750	2.42	36.30	163.00/M
F115-ND	1	1.24	18.60	84.00/M
F116-ND	1.250	1.24	18.60	84.00/M
F117-ND	1.500	1.24	18.60	84.00/M
F118-ND	1.600	1.24	18.60	84.00/M
F119-ND	2	1.24	18.60	84.00/M
F120-ND	2.500	1.24	18.60	84.00/M
F121-ND	3	1.24	18.60	84.00/M
F122-ND	4	1.98	29.70	134.00/M
F123-ND	5	1.98	29.70	134.00/M
F124-ND	6	1.98	29.70	134.00/M
F125-ND	7	2.14	42.80	321.00/M
F126-ND	8	2.74	41.10	185.00/M
F127-ND	10	2.74	41.10	185.00/M

3AG SLO-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	5	100	1,000
F300-ND	.010	6.90	104.00	467.00/M
F301-ND	.031	6.90	104.00	467.00/M
F302-ND	.040	6.90	104.00	467.00/M
F303-ND	.062	4.86	72.90	328.00/M
F304-ND	.100	4.86	72.90	328.00/M
F305-ND	.125	4.86	72.90	328.00/M
F306-ND	.150	4.86	72.90	328.00/M
F307-ND	.175	4.86	72.90	328.00/M
F308-ND	.187	4.86	72.90	328.00/M
F309-ND	.200	4.86	72.90	328.00/M
F310-ND	.250	4.86	72.90	328.00/M
F311-ND	.300	4.86	72.90	328.00/M
F312-ND	.375	4.86	72.90	328.00/M
F313-ND	.400	4.86	72.90	328.00/M
F314-ND	.500	4.86	72.90	328.00/M
F315-ND	.600	4.86	72.90	328.00/M
F316-ND	.700	4.86	72.90	328.00/M
F317-ND	.750	4.86	72.90	328.00/M
F318-ND	.800	4.86	72.90	328.00/M
F319-ND	1	4.86	72.90	328.00/M
F320-ND	1.200	4.42	66.30	298.00/M
F321-ND	1.250	4.42	66.30	298.00/M
F322-ND	1.500	4.42	66.30	298.00/M
F323-ND	1.600	4.42	66.30	298.00/M
F324-ND	1.800	4.42	66.30	298.00/M
F325-ND	2	4.42	66.30	298.00/M
F326-ND	2.250	4.42	66.30	298.00/M
F327-ND	2.500	4.42	66.30	298.00/M
F328-ND	2.800	4.42	66.30	298.00/M
F329-ND	3	4.42	66.30	298.00/M
F330-ND	3.200	4.42	66.30	298.00/M
F331-ND	4	4.42	66.30	298.00/M
F332-ND	5	4.42	66.30	298.00/M
F333-ND	6.250	3.54	7.08	53.10/M
F334-ND	7	3.54	53.10	239.00/M
F335-ND	8	3.54	53.10	239.00/M
F336-ND	10	3.54	53.10	239.00/M
F337-ND	12	3.54	53.10	239.00/M
F338-ND	15	3.54	53.10	239.00/M
F339-ND	20	3.54	53.10	239.00/M
F340-ND	25	3.54	53.10	239.00/M
F341-ND	30	3.54	53.10	239.00/M

3AG PANEL FUSEHOLDER



Black phenolic conforming to MIL-M-14, type CFG. Rated at 20 amps for any voltage to 250. Includes neoprene washer, hex nut, and lock washer.

Part No.	1	10	100
F004-ND	1.89	15.00	94.50

National Semiconductor

MA1026 Time-Temp. Clock Module

Giant .7 Inch 4-Digit LED Display

- F° and/or C° and virtually any number of sensors
- 50/60Hz line frequency operation
- 12 or 24 Hour Display

Typical Applications Include: Clock Radio Timers, Alarm Clock, Desk Clock, TV and Stereo Timer, Instrument Panel Clock, Digital Thermometer and much more.

Part No.	Description	Price
MA1026M	MA1026 clock module only	$18.95
MA1026P	Digi-Key switch panel kit (P.C. Board, 12 switches, two LM334Z temp. sensors, two KOA32 potentiometers, instructions).	11.95
MA1026T	110 VAC transformer for MA1026M	3.10
MA1026B	Alarm buzzer for MA1026M	3.36
MA1026K	MA1026M, P, T, B	34.95

For additional sensor units, you will need:

LM334Z	Temperature Sensor	1.51
K4A32	300 ohm Potentiometer	.32
502PB	Normally open SPST Switch	.56

"Programmable" Clock Modules

0.7" or 0.84" Red 4-Digit LED Display

User Programmable For:

- 12 or 24 hour display
- 50/60 Hz line frequency
- Fixed or flashing dot (colon indicator)
- Display; hours and minutes, minute and seconds, alarm time, and sleep time
- Battery back-up in case of power failure
- Typical applications include: clock radio timer, alarm clock, desk clock, instrument panel clock, and many more.

MA1020 — 0.84 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1020M	MA1020 Clock Module only	$15.95
MA1020P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	7.95
MA1020T	110 VAC Transformer for MA1020M	3.10
MA1020B	Buzzer for MA1020M alarm output	3.36
MA1020K	MA1020M, P, B and T	29.95

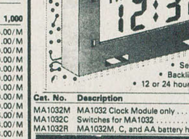
MA1023 — 0.7 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1023M	MA1023 Clock Module only	$ 8.95
MA1023P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	6.95
MA1023T	110 VAC Transformer for MA1023M	3.10
MA1023B	Buzzer for MA1023 alarm output	3.36
MA1023K	MA1023M, P, B and T	21.30

.5" 4-Digit LCD Clock

National Semiconductor MA1032 Clock Module

- One year use on a 90mA hour battery (typ.)
- Buffered alarm and sleep outputs
- AC or DC alarm output
- Hold function



- Seconds display
- Backlighted display
- 12 or 24 hour time display

Cat. No.	Description	Price
MA1032M	MA1032 Clock Module only	$17.95
MA1032C	Switches for MA1032	2.85
MA1032R	MA1032M, C, and AA battery holder	21.20

DIGI-CLOCK KIT

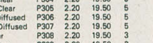
12 VDC — Ideal for Car, Van or Boat!

- Trouble-free Module!
- 270° Swivel Mount
- Inlaid Walnut Chrome Trim Bezel!
- Ideal for Car, Van or Boat!
- 3-5/8"x2-3/16" Tall x 2-1/8" Deep!
- Quick and Easy to Install!

Part No. 5001K ONLY $17.95

LED's — Red, Green, Amber, Orange

3 mm, 4 mm, 5 mm; Round, Rectangular Arrow



Color	Part No.	Price 10	100	Size MM	Shape
Red Diffused	P300	2.20	19.50	5	Round
Red Clear	P301	2.20	19.50	5	Round
Green Clear	P302	2.20	19.50	5	Round
Green Diffused	P303	2.20	19.50	5	Round
Amber Clear	P304	2.20	19.50	5	Round
Orange Clear	P305	2.20	19.50	5	Round
Amber Diffused	P306	2.20	19.50	5	Round
Orange Diffused	P307	2.20	19.50	5	Round
Red Clear	P308	2.20	19.50	3	Round
Green Clear	P309	2.20	19.50	3	Round
Amber Clear	P310	2.20	19.50	3	Round
Red Clear	P311	2.20	19.50	4	Round
Green Clear	P312	2.20	19.50	4	Round
Amber Diffused	P314	2.20	19.50	4	Round
Red Diffused	P315	2.20	19.50	3x5	Rectangle
Green Diffused	P316	3.12	26.00	3x5	Rectangle
Amber Diffused	P317	3.12	26.00	3x5	Rectangle
Red Diffused	P318	2.20	19.50	4x4.5	Arrow
Green Diffused	P319	3.12	26.00	4x4.5	Arrow
Amber Diffused	P320	3.12	26.00	4x4.5	Arrow

Panasonic LED Numeric Displays

Red, Green, Amber and Orange Colors — Direct Drive

Comm. Anode	Comm. Cath.	Digits	Color	Size In.	1	10	100
P322	P343	8	Red	.3	1.25	11.50	105.00
P323	P344		Green	.3	1.58	14.50	132.00
P324	P345		Amber	.3	1.93	17.70	162.00
P325	P346		Orange	.3	1.93	17.70	162.00
P326	P347		Red	.43	1.45	13.30	122.00
P327	P348		Green	.43	1.78	16.30	149.00
P328	P349		Amber	.43	1.93	17.70	162.00
P329	P350		Orange	.43	2.10	19.32	176.00
P330	P351	8	Red	.57	1.58	14.50	132.00
P331	P352		Green	.57	1.90	17.50	159.00
P332	P353		Amber	.57	1.93	17.70	162.00
P333	P354		Orange	.57	2.25	20.70	188.00
P334	P355	88	Red	.43	2.10	19.30	175.00
P335	P356		Green	.43	2.45	22.50	205.00
P336	P357		Amber	.43	3.08	28.30	257.00
P337	P358		Red	.57	2.10	19.30	175.00
P338	P359		Green	.57	2.45	22.50	205.00
P339	P360		Amber	.57	3.58	32.90	299.00
P340*	P361*	8888	Red	.28	5.35	49.20	448.00
P341*	P362*		Green	.28	6.15	56.60	515.00

* Multiplexed Display

Silicon Transistors

DIGI-KEY Part No.	1	10	100	1,000
2N3055	1.44	12.00	108.00	960.00
2N3904	.20	1.79	16.25	146.25
2N3906	.20	1.79	16.25	146.25
2N4124	.21	1.93	17.50	157.50
2N4126	.22	2.01	18.25	164.25
2N4401	.21	1.93	17.50	157.50
2N4403	.21	1.93	17.50	157.50
2N4410	.30	2.70	24.38	219.38
2N5087	.24	2.20	20.00	180.00
2N5089	.24	2.20	20.00	180.00
2N5210	.27	2.48	22.50	202.50
2N5457	.54	4.86	43.88	394.88
92PU01A	.38	3.42	30.88	277.88
92PU10	.38	3.42	30.88	277.88
92PU45A	.41	3.69	33.32	299.82
92PU51A	.38	3.42	30.88	277.88
MJ2955	1.47	13.48	122.50	1102.25
MJE172	.74	6.66	60.13	541.13
MJE182	.65	5.55	46.25	416.25
MJE3439	.56	4.80	40.00	360.00
MJE344	.68	6.12	55.25	497.25
MJE370	.89	8.01	72.32	650.82
MJE371	1.10	9.90	89.38	804.38
MJE520	.86	7.74	69.88	628.88
MJE521	.86	7.74	69.88	628.88
MJE703	1.13	10.17	91.82	826.31
MJE712	.74	6.66	60.13	541.13
MJE722	.74	6.66	60.13	541.13
MJE803	1.01	9.09	82.07	738.57
MPF102	.54	4.95	45.00	405.00
MPS2222A	.21	1.93	17.50	157.50
MPS2369A	.24	2.20	20.00	180.00
MPS2907A	.24	2.20	20.00	180.00
MPS3392	.23	2.07	18.75	169.00
MPS3393	.21	1.93	17.50	157.50
MPS3394	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.21	1.93	17.50	157.50
MPS3565	.21	1.93	17.50	157.50
MPS3638A	.21	1.93	17.50	157.50
MPS3641	.21	1.93	17.50	157.50
MPS3643	.21	1.93	17.50	157.50
MPS918	.22	1.98	17.88	160.88
MPS930	.21	1.93	17.50	157.50
MPSA13	.27	2.48	22.50	202.50
TIP112	.98	8.40	70.00	630.00
TIP117	1.12	10.08	91.00	819.00
TIP120	1.17	10.73	97.50	877.50
TIP122	1.54	13.20	110.00	990.00
TIP127	1.54	13.20	110.00	990.00
TIP132	2.32	20.88	188.50	1696.50
TIP135	2.32	20.88	188.50	1696.50
TIP29C	.81	6.90	57.50	517.50
TIP30C	.81	6.90	57.50	517.50
TIP31C	.98	8.40	70.00	630.00
TIP32C	1.02	8.70	72.50	652.50
TIP61C	.81	6.90	57.50	517.50
TIP62C	.81	6.90	57.50	517.50

PCB Transformers

Ratings Based on 20% Regulation

DIGI-KEY Part No.	Output Series VCT@MA	1	10	25	50
T100-ND	10 @ 440	7.00	55.00	118.75	200.00
T101-ND	12.6 @ 350	7.00	55.00	118.75	200.00
T102-ND	16 @ 260	7.00	55.00	118.75	200.00
T103-ND	20 @ 220	7.00	55.00	118.75	200.00
T104-ND	24 @ 180	7.00	55.00	118.75	200.00
T105-ND	28 @ 160	7.00	55.00	118.75	200.00
T106-ND	34 @ 125	7.00	55.00	118.75	200.00
T107-ND	40 @ 110	7.00	55.00	118.75	200.00
T110-ND	10 @ 1000	8.37	62.80	134.50	239.00
T111-ND	12.6 @ 800	8.37	62.80	134.50	239.00
T112-ND	16 @ 640	8.37	62.80	134.50	239.00
T113-ND	20 @ 500	8.37	62.80	134.50	239.00
T114-ND	24 @ 450	8.37	62.80	134.50	239.00
T115-ND	28 @ 360	8.37	62.80	134.50	239.00
T116-ND	34 @ 300	8.37	62.80	134.50	239.00
T117-ND	40 @ 250	8.37	62.80	134.50	239.00
T120-ND	10 @ 2400	11.45	85.90	186.00	326.50
T121-ND	12.6 @ 2000	11.45	85.90	186.00	326.50
T122-ND	16 @ 1500	11.45	85.90	186.00	326.50
T123-ND	20 @ 1200	11.45	85.90	186.00	326.50
T124-ND	24 @ 1000	11.45	85.90	186.00	326.50
T125-ND	28 @ 800	11.45	85.90	186.00	326.50
T126-ND	34 @ 700	11.45	85.90	186.00	326.50
T127-ND	40 @ 600	11.45	85.90	186.00	573.00

5% Carbon Film Resistors

Specifications:

Rating Wattage	¼ W	½ W
Max. Working Voltage	250V	350V
Rated Ambient Temp.	70°C	
Operating Temp. Range	-55°C to +155°C	
Resistance Range	2.2Ω to 5.1MΩ	
Resistance Tolerance	±5%	
Series	E24	

Dimensions:

Style		¼ W	½ W
Body	Length (L)	6.5 ± 0.4	9.5 ± 0.5
	Diameter (D)	2.3 ± 1.0	3.7 ± 0.2
Lead Wire	Length (H)	28 ± 1.0	28 ± 1.0
	Diameter (d)	0.6	0.7

5% Carbon Film Resistor Values in Ohms

−1.0	−9.1	−82	−750	−6.8K	−62K	−560K
−1.1	−10	−91	−820	−7.5K	−68K	−620K
−1.2	−11	−100	−910	−8.2K	−75K	−680K
−1.3	−12	−110	−1.0K	−9.1K	−82K	−750K
−1.5	−13	−120	−1.1K	−10K	−91K	−820K
−1.6	−15	−130	−1.2K	−11K	−100K	−910K
−1.8	−16	−150	−1.3K	−12K	−110K	−1.0M
−2.0	−18	−160	−1.5K	−13K	−120K	−1.1M
−2.2	−20	−180	−1.6K	−15K	−130K	−1.2M
−2.4	−22	−200	−1.8K	−16K	−150K	−1.3M
−2.7	−24	−220	−2.0K	−18K	−160K	−1.5M
−3.0	−27	−240	−2.2K	−20K	−180K	−1.6M
−3.3	−30	−270	−2.4K	−22K	−200K	−1.8M
−3.6	−33	−300	−2.7K	−24K	−220K	−2.0M
−3.9	−36	−330	−3.0K	−27K	−240K	−2.2M
−4.3	−39	−360	−3.3K	−30K	−270K	−2.4M
−4.7	−43	−390	−3.6K	−33K	−300K	−2.7M
−5.1	−47	−430	−3.9K	−36K	−330K	−3.0M
−5.6	−51	−470	−4.3K	−39K	−360K	−3.3M
−6.2	−56	−510	−4.7K	−43K	−390K	−3.6M
−6.8	−62	−560	−5.1K	−47K	−430K	−3.9M
−7.5	−68	−620	−5.6K	−51K	−470K	−4.3M
−8.2	−75	−680	−6.2K	−56K	−510K	−4.7M

When ordering individual resistors, place a "Q" after the ohms value for ¼W and an "H" for ½W resistors.

¼ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS125 — 5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc. to 1M ohm of the ¼W 5% resistor for a total of 365 pieces. **$9.90**

RS225 — 5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ¼W 5% resistor for a total of 360 pieces. **$9.90**

½ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS150 — 5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc. to 1M ohm of the ½W 5% resistor for a total of 365 pieces. **$9.90**

RS250 — 5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ½W 5% resistor for a total of 360 pieces. **$9.90**

Remember a "Q" after the resistance value indicates a ¼ watt, an "H" indicates a ½ watt (i.e., 10KQ or 10KH). Prices are for single values.

¼ Watt ....5 for 25¢; 200 for $3.40; 1000 for $13.00
½ Watt ....5 for 25¢; 200 for $3.60; 1000 for $16.00

In order to receive the pricing below, the resistor part number must be followed by a "-ND" (i.e., 10KQ-ND) and ordered in multiples of 1,000 only.

Price /1000	1M	10M	50M	100M	500M	1000M
¼W	8.10/M	7.20/M	5.80/M	5.40/M	4.50/M	4.00/M
½W	12.25/M	10.25/M	9.50/M	8.90/M	7.40/M	6.65/M

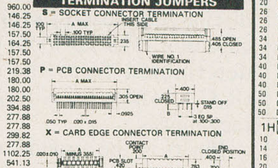
RN Robinson Nugent, Inc.

TERMINATION JUMPERS

S = SOCKET CONNECTOR TERMINATION

P = PCB CONNECTOR TERMINATION

X = CARD EDGE CONNECTOR TERMINATION



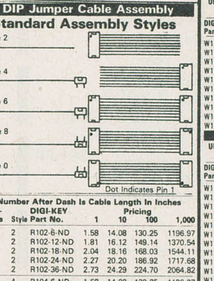
Number After Dash Is Cable Length In Inches

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
10	S	R300-ND	1.15	10.26	94.90	872.10
14	S	R301-ND	1.40	12.52	115.81	1064.20
16	S	R302-ND	1.61	14.32	132.46	1217.20
20	S	R303-ND	1.86	16.56	153.18	1407.60
26	S	R304-ND	2.43	21.60	199.80	1836.00
34	S	R305-ND	3.15	28.00	259.00	2380.00
40	S	R306-ND	3.73	33.20	307.10	2822.00
50	S	R307-ND	4.65	41.40	382.95	3519.00
10	P	R400-ND	1.01	9.00	83.25	765.00
20	P	R401-ND	1.21	10.84	100.27	921.40
26	P	R402-ND	1.52	13.52	125.06	1149.20
34	P	R403-ND	1.86	16.56	153.18	1407.60
40	P	R404-ND	2.11	18.82	174.08	1599.70
50	P	R405-ND	2.65	23.60	218.30	2006.00
20	X	R500-ND	2.36	21.00	194.25	1785.00
26	X	R501-ND	2.65	23.60	218.30	2006.00
34	X	R502-ND	3.26	29.00	268.25	2465.00
40	X	R503-ND	3.80	33.80	312.65	2873.00
50	X	R504-ND	4.74	42.20	390.35	3587.00
1A	SOCKET CONNECTOR					
10	1A	R309-36-ND	2.13	19.01	175.87	1616.19
14	1A	R310-36-ND	2.78	24.73	228.80	2102.56
16	1A	R311-36-ND	3.18	28.33	262.05	2408.05
20	1A	R312-36-ND	3.83	34.06	315.12	2895.78
26	1A	R313-36-ND	4.99	44.36	410.36	3770.94
34	1A	R314-36-ND	6.49	57.76	534.33	4910.11
40	1A	R316-36-ND	7.67	68.21	630.99	5798.36
50	1A	R317-36-ND	9.58	85.17	787.82	7239.45
2A	PCB CONNECTOR					
10	2A	R406-36-ND	1.99	17.75	164.22	1509.09
20	2A	R407-36-ND	3.18	28.34	262.21	2409.58
26	2A	R408-26-ND	4.08	36.28	335.62	3084.14
34	2A	R409-36-ND	5.21	46.32	428.51	3937.71
40	2A	R410-36-ND	6.05	53.83	497.98	4576.06
50	2A	R411-36-ND	7.57	67.37	623.17	5726.45
3A	CARD EDGE CONNECTOR					
20	3A	R505-36-ND	4.33	38.50	356.19	3273.18
26	3A	R506-36-ND	5.21	46.36	428.86	3940.94
34	3A	R507-36-ND	6.61	58.76	543.56	4994.94
40	3A	R509-36-ND	7.74	68.81	636.54	5849.36
50	3A	R510-36-ND	9.67	85.97	795.22	7307.45
1B	SOCKET CONNECTOR — SOCKET CONNECTOR					
10	1B	R319-6-ND	2.47	21.97	203.29	1868.13
10	1B	R319-18-ND	2.80	24.89	230.29	2116.24
10	1B	R319-36-ND	3.29	29.27	270.78	2488.29
14	1B	R320-6-ND	3.04	27.08	250.50	2301.97
14	1B	R320-18-ND	3.50	31.16	288.28	2649.11
14	1B	R320-36-ND	4.19	37.25	344.61	3166.76
16	1B	R321-6-ND	3.48	30.97	286.51	2632.87
16	1B	R321-18-ND	4.01	35.64	329.71	3029.82
16	1B	R321-36-ND	4.79	42.65	394.51	3625.25
20	1B	R322-6-ND	4.05	36.03	333.35	3063.23
20	1B	R322-18-ND	4.71	41.87	387.33	3559.29
20	1B	R322-36-ND	5.69	50.62	468.30	4303.38
26	1B	R323-6-ND	5.28	46.99	434.69	3994.49
26	1B	R323-18-ND	6.14	54.58	504.88	4639.47
26	1B	R323-36-ND	7.42	65.96	610.16	5606.94
34	1B	R324-6-ND	6.85	60.96	563.88	5181.68
34	1B	R324-18-ND	7.97	70.86	655.66	6025.05
34	1B	R324-36-ND	7.39	65.76	608.33	5590.11
40	1B	R325-6-ND	8.12	72.23	668.18	6140.06
40	1B	R325-18-ND	9.43	83.90	776.14	7132.18
40	1B	R325-36-ND	11.40	101.41	938.09	8620.36
50	1B	R326-6-ND	10.13	90.09	833.37	7658.07
50	1B	R326-18-ND	11.77	104.68	968.33	8898.22
50	1B	R326-36-ND	14.23	126.57	1170.77	10758.45
2B	PCB CONNECTOR — PCB CONNECTOR					
10	2B	R412-6-ND	2.18	19.45	179.99	1654.01
10	2B	R412-18-ND	2.51	22.37	206.98	1902.04
10	2B	R412-36-ND	3.00	26.75	247.47	2274.09
20	2B	R413-6-ND	2.76	24.59	227.53	2090.83
20	2B	R413-18-ND	3.42	30.43	281.51	2586.89
20	2B	R413-36-ND	4.40	39.18	362.48	3330.98
26	2B	R414-6-ND	3.46	30.83	285.21	2620.89
26	2B	R414-18-ND	4.32	38.42	355.40	3265.87
26	2B	R414-36-ND	5.60	49.80	460.68	4233.34
34	2B	R415-6-ND	4.28	38.08	352.24	3236.88
34	2B	R415-18-ND	5.40	43.00	444.02	4080.25
34	2B	R415-36-ND	7.07	62.88	581.69	5345.31
40	2B	R416-6-ND	4.89	43.47	402.15	3695.46
40	2B	R416-18-ND	6.20	55.14	510.11	4687.58
40	2B	R416-36-ND	8.17	72.65	672.06	6175.76
50	2B	R417-6-ND	6.13	54.49	504.07	4632.07
50	2B	R417-18-ND	7.77	69.08	639.03	5872.22
50	2B	R417-36-ND	10.23	90.97	841.47	7732.45
3B	CARD EDGE CONNECTOR — CARD EDGE CONNECTOR					
20	3B	R511-6-ND	5.05	44.91	415.49	3818.03
20	3B	R511-18-ND	5.70	50.75	469.47	4314.09
20	3B	R511-36-ND	6.69	59.50	550.44	5058.18
26	3B	R512-6-ND	5.73	50.99	471.69	4334.49
26	3B	R512-18-ND	6.59	58.58	541.88	4979.47
26	3B	R512-36-ND	7.87	69.96	647.16	5946.94
34	3B	R513-6-ND	7.08	62.96	582.38	5351.68
34	3B	R513-18-ND	8.19	72.88	674.16	6195.05
34	3B	R513-36-ND	9.87	87.76	811.81	7459.94
40	3B	R514-6-ND	8.26	73.43	679.28	6242.06
40	3B	R514-18-ND	9.57	85.10	787.24	7234.18
40	3B	R514-36-ND	11.54	102.61	949.19	8722.36
50	3B	R515-6-ND	10.31	91.69	848.17	7794.07
50	3B	R515-18-ND	11.95	106.28	983.13	9034.22
50	3B	R515-36-ND	14.41	128.17	1185.57	10894.45
C	SOCKET CONNECTOR — PCB CONNECTOR					
10	C	R328-6-ND	2.33	20.71	191.65	1761.11
10	C	R328-18-ND	2.65	23.63	218.64	2009.14
10	C	R328-36-ND	3.15	28.01	259.12	2381.19
20	C	R329-6-ND	3.41	30.31	280.44	2577.03
20	C	R329-18-ND	4.06	36.15	334.42	3073.09
20	C	R329-36-ND	5.05	44.90	415.39	3817.18
26	C	R330-6-ND	4.37	38.91	359.95	3307.69
26	C	R330-18-ND	5.23	46.50	430.14	3952.67
26	C	R330-36-ND	6.51	57.88	535.42	4920.14
34	C	R331-6-ND	5.57	49.52	458.06	4209.28
34	C	R331-18-ND	6.68	59.44	549.84	5052.65
34	C	R331-36-ND	8.36	74.32	687.51	6317.71
40	C	R332-6-ND	6.50	57.85	535.16	4917.76
40	C	R332-18-ND	7.82	69.52	643.13	5909.88
40	C	R332-36-ND	9.79	87.03	805.08	7398.06
50	C	R333-6-ND	8.13	72.29	668.72	6145.07
50	C	R333-18-ND	9.77	86.88	803.68	7385.22
50	C	R333-36-ND	12.23	108.77	1006.12	9245.45
E	PCB CONNECTOR — CARD EDGE CONNECTOR					
20	E	R418-6-ND	3.91	34.75	321.51	2954.43
20	E	R418-18-ND	4.56	40.59	375.49	3450.49
20	E	R418-36-ND	5.55	49.34	456.46	4194.58
26	E	R419-6-ND	4.60	40.91	378.45	3477.69
26	E	R419-18-ND	5.45	48.50	448.64	4122.67
26	E	R419-36-ND	6.73	59.88	553.92	5090.14
34	E	R420-6-ND	5.68	50.52	467.31	4294.28
34	E	R420-18-ND	6.79	60.44	559.09	5137.65
34	E	R420-36-ND	8.47	75.32	696.76	6402.71
40	E	R421-6-ND	6.57	58.45	540.71	4968.76
40	E	R421-18-ND	7.88	70.12	648.68	5960.88
40	E	R421-36-ND	9.85	87.63	810.63	7449.06
50	E	R422-6-ND	8.22	73.09	676.12	6213.07
50	E	R422-18-ND	9.86	87.68	811.08	7453.22
50	E	R422-36-ND	12.32	109.57	1013.52	9313.45

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
D	SOCKET CONNECTOR — CARD EDGE CONNECTOR					
20	D	R516-6-ND	4.55	40.47	374.42	3440.63
20	D	R516-18-ND	5.21	46.31	428.40	3936.69
20	D	R516-36-ND	6.19	55.06	509.37	4680.78
26	D	R517-6-ND	5.51	48.99	453.19	4164.49
26	D	R517-18-ND	6.36	56.58	523.38	4809.47
26	D	R517-36-ND	7.64	67.96	628.66	5776.94
34	D	R518-6-ND	6.97	61.96	573.13	5266.68
34	D	R518-18-ND	8.08	71.88	664.91	6110.05
34	D	R518-36-ND	9.76	86.76	802.58	7375.11
40	D	R519-6-ND	8.19	72.83	673.73	6191.06
40	D	R519-18-ND	9.50	84.50	781.69	7183.18
40	D	R519-36-ND	11.47	102.01	943.64	8671.36
50	D	R520-6-ND	10.22	90.89	840.77	7726.07
50	D	R520-18-ND	11.86	105.48	975.73	8966.22
50	D	R520-36-ND	14.32	127.37	1178.17	10826.45
1H	SOCKET CONNEC — SOCKET CONNEC — SOCKET CONNEC					
10	1H	R334-6-ND	3.62	32.23	298.20	2740.23
14	1H	R335-6-ND	4.45	39.60	366.31	3366.17
16	1H	R336-6-ND	5.09	45.29	418.97	3850.07
20	1H	R337-6-ND	5.91	52.59	486.53	4470.83
26	1H	R338-6-ND	7.71	69.59	634.49	5830.49
34	1H	R339-6-ND	10.00	88.96	822.88	7561.68
40	1H	R340-6-ND	11.86	105.43	975.28	8962.06
50	1H	R341-6-ND	14.79	131.49	1216.32	11177.07
2H	PCB CONNECTOR — PCB CONNECTOR — PCB CONNECTOR					
10	2H	R423-6-ND	3.20	28.45	263.24	2419.01
20	2H	R424-6-ND	3.98	35.43	327.80	3012.23
26	2H	R425-6-ND	4.98	44.35	410.27	3770.09
34	2H	R426-6-ND	6.14	54.64	505.42	4644.48
40	2H	R427-6-ND	7.00	62.29	576.23	5295.16
50	2H	R428-6-ND	8.78	78.09	722.37	6638.07
3H	CARD EDGE — CARD EDGE — CARD EDGE					
20	3H	R521-6-ND	7.41	65.91	609.74	5603.03
26	3H	R522-6-ND	8.39	74.59	689.99	6340.49
34	3H	R523-6-ND	10.34	91.96	850.63	7816.68
40	3H	R524-6-ND	12.06	107.23	991.93	9115.06
50	3H	R525-6-ND	15.06	133.89	1238.52	11381.07

DIP Jumper Cable Assembly

Standard Assembly Styles



Number After Dash Is Cable Length In Inches

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
14	2	R102-6-ND	1.58	14.08	130.25	1196.97
14	2	R102-12-ND	1.81	16.12	149.14	1370.54
14	2	R102-18-ND	2.04	18.16	168.03	1544.11
14	2	R102-24-ND	2.27	20.20	186.92	1717.68
14	2	R102-36-ND	2.73	24.29	224.70	2064.82
14	4	R104-6-ND	1.58	14.08	130.25	1196.97
14	4	R104-12-ND	1.81	16.12	149.14	1370.54
14	4	R104-18-ND	2.04	18.16	168.03	1544.11
14	4	R104-24-ND	2.27	20.20	186.92	1717.68
14	4	R104-36-ND	2.73	24.29	224.70	2064.82
14	6	R106-6-ND	2.93	26.12	241.62	2220.37
14	6	R106-12-ND	3.16	28.16	260.51	2393.94
14	6	R106-18-ND	3.39	30.20	279.40	2567.51
14	6	R106-24-ND	3.62	32.24	298.29	2741.08
14	6	R106-36-ND	4.08	36.33	336.07	3088.22
14	8	R108-6-ND	2.93	26.12	241.62	2220.37
14	8	R108-12-ND	3.16	28.16	260.51	2393.94
14	8	R108-18-ND	3.39	30.20	279.40	2567.51
14	8	R108-24-ND	3.62	32.24	298.29	2741.08
14	8	R108-36-ND	4.08	36.33	336.07	3088.22
14	0	R110-6-ND	2.93	26.12	241.62	2220.37
14	0	R110-12-ND	3.16	28.16	260.51	2393.94
14	0	R110-18-ND	3.39	30.20	279.40	2567.51
14	0	R110-24-ND	3.62	32.24	298.29	2741.08
14	0	R110-36-ND	4.08	36.33	336.07	3088.22
16	2	R112-6-ND	1.67	14.87	137.60	1264.46
16	2	R112-12-ND	1.93	17.21	159.19	1462.85
16	2	R112-18-ND	2.19	19.54	180.80	1661.41
16	2	R112-24-ND	2.46	21.88	202.39	1859.80
16	2	R112-36-ND	2.98	26.55	245.58	2256.75
16	4	R114-6-ND	1.67	14.87	137.60	1264.46
16	4	R114-12-ND	1.93	17.21	159.19	1462.85
16	4	R114-18-ND	2.19	19.54	180.80	1661.41
16	4	R114-24-ND	2.46	21.88	202.39	1859.80
16	4	R114-36-ND	2.98	26.55	245.58	2256.75
16	6	R116-6-ND	3.30	29.41	272.09	2500.36
16	6	R116-12-ND	3.57	31.75	293.68	2698.75
16	6	R116-18-ND	3.83	34.08	315.29	2897.31
16	6	R116-24-ND	4.09	36.42	336.88	3095.70
16	6	R116-36-ND	4.62	41.09	380.08	3492.65
16	8	R118-6-ND	3.30	29.41	272.09	2500.36
16	8	R118-12-ND	3.57	31.75	293.68	2698.75
16	8	R118-18-ND	3.83	34.08	315.29	2897.31
16	8	R118-24-ND	4.09	36.42	336.88	3095.70
16	8	R118-36-ND	4.62	41.09	380.08	3492.65
16	0	R120-6-ND	3.30	29.41	272.09	2500.36
16	0	R120-12-ND	3.57	31.75	293.68	2698.75
16	0	R120-18-ND	3.83	34.08	315.29	2897.31
16	0	R120-24-ND	4.09	36.42	336.88	3095.70
16	0	R120-36-ND	4.62	41.09	380.08	3492.65
24	2	R122-6-ND	2.63	23.38	216.28	1987.47
24	2	R122-12-ND	3.02	26.88	248.67	2285.14
24	2	R122-18-ND	3.41	30.38	281.07	2582.81
24	2	R122-24-ND	3.81	33.88	313.46	2880.48
24	2	R122-36-ND	4.60	40.89	378.25	3475.82
24	4	R124-6-ND	2.63	23.38	216.28	1987.47
24	4	R124-12-ND	3.02	26.88	248.67	2285.14
24	4	R124-18-ND	3.41	30.38	281.07	2582.81
24	4	R124-24-ND	3.81	33.88	313.46	2880.48
24	4	R124-36-ND	4.60	40.89	378.25	3475.82
24	6	R126-6-ND	4.86	43.26	400.17	3677.27
24	6	R126-12-ND	5.26	46.76	432.56	3974.94
24	6	R126-18-ND	5.65	50.26	464.96	4272.61
24	6	R126-24-ND	6.04	53.76	497.35	4570.28
24	6	R126-36-ND	6.83	60.77	562.14	5165.62
24	8	R128-6-ND	4.86	43.26	400.17	3677.27
24	8	R128-12-ND	5.26	46.76	432.56	3974.94
24	8	R128-18-ND	5.65	50.26	464.96	4272.61
24	8	R128-24-ND	6.04	53.76	497.35	4570.28
24	8	R128-36-ND	6.83	60.77	562.14	5165.62
24	0	R130-6-ND	4.86	43.26	400.17	3677.27
24	0	R130-12-ND	5.26	46.76	432.56	3974.94
24	0	R130-18-ND	5.65	50.26	464.96	4272.61
24	0	R130-24-ND	6.04	53.76	497.35	4570.28
24	0	R130-36-ND	6.83	60.77	562.14	5165.62
40	2	R132-6-ND	3.26	29.03	268.58	2468.06
40	2	R132-12-ND	3.92	34.87	322.56	2964.12
40	2	R132-18-ND	4.57	40.70	376.54	3460.18
40	2	R132-24-ND	5.23	46.54	430.53	3956.24
40	2	R132-36-ND	6.54	58.21	538.49	4948.36
40	4	R134-6-ND	3.26	29.03	268.58	2468.06
40	4	R134-12-ND	3.92	34.87	322.56	2964.12
40	4	R134-18-ND	4.57	40.70	376.54	3460.18
40	4	R134-24-ND	5.23	46.54	430.53	3956.24
40	4	R134-36-ND	6.54	58.21	538.49	4948.36
40	6	R136-6-ND	5.87	52.23	483.18	4440.06
40	6	R136-12-ND	6.53	58.07	537.16	4936.12
40	6	R136-18-ND	7.18	63.90	591.14	5432.18
40	6	R136-24-ND	7.84	69.74	645.13	5928.24
40	6	R136-36-ND	9.15	81.41	753.09	6920.36
40	8	R138-6-ND	5.87	52.23	483.18	4440.06
40	8	R138-12-ND	6.53	58.07	537.16	4936.12
40	8	R138-18-ND	7.18	63.90	591.14	5432.18
40	8	R138-24-ND	7.84	69.74	645.13	5928.24
40	8	R138-36-ND	9.15	81.41	753.09	6920.36
40	0	R140-6-ND	5.87	52.23	483.18	4440.06
40	0	R140-12-ND	6.53	58.07	537.16	4936.12
40	0	R140-18-ND	7.18	63.90	591.14	5432.18
40	0	R140-24-ND	7.84	69.74	645.13	5928.24
40	0	R140-36-ND	9.15	81.41	753.09	6920.36

alpha wire cable tubing

Hookup Wire, Stranded, PVC Insulated

4 Color MIL-W-16878D Type B · 600 Volt · -55° to +105°C

White	Black	Green	Red	Price 100 Ft.	AWG
W100W-ND	W100B-ND	W100G-ND	W100R-ND	7.32	32
W101W-ND	W101B-ND	W101G-ND	W101R-ND	6.01	30
W102W-ND	W102B-ND	W102G-ND	W102R-ND	5.71	28
W103W-ND	W103B-ND	W103G-ND	W103R-ND	5.90	26
W104W-ND	W104B-ND	W104G-ND	W104R-ND	5.82	24
W105W-ND	W105B-ND	W105G-ND	W105R-ND	6.37	22
W106W-ND	W106B-ND	W106G-ND	W106R-ND	8.03	20
W107W-ND	W107B-ND	W107G-ND	W107R-ND	8.35	18
W108W-ND	W108B-ND	W108G-ND	W108R-ND	10.90	16
W109W-ND	W109B-ND	W109G-ND	W109R-ND	24.52	14

Hookup Wire, Solid, PVC Insulated

4 Color MIL-W-76B Type MW · 1,000 Volt · -40° to +80°C

White	Black	Green	Red	Price 100 Ft.	AWG
W110W-ND	W110B-ND	W110G-ND	W110R-ND	5.48	24
W111W-ND	W111B-ND	W111G-ND	W111R-ND	5.31	22
W112W-ND	W112B-ND	W112G-ND	W112R-ND	6.32	20
W113W-ND	W113B-ND	W113G-ND	W113R-ND	8.41	18

Multiconductor, Solid, PVC Insulated Cable

Color Coded · Gray Jacket · Tinned Copper Conductors

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. Of Cond.	Conductor AWG	Strand	Voltage Rating
W140-X-ND	15.27	54.16	106.65	2	22	1	150V
W141-X-ND	35.04	121.94	231.00	2	18	1	300V
W142-X-ND	37.58	145.83	306.89	3	18	1	300V
W143-X-ND	50.67	190.79	363.15	4	18	1	300V

Multipair, Individually Foil Shielded Cable

UL2464 CSA Certified · Drain Wire · -20° to +80°C · 300 Volts
22 AWG-7/30 · X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	Nom. O.D. Inches	mm
W170-X-ND	39.44	139.94	279.87	2	.316	8.03
W171-X-ND	52.03	185.63	371.27	3	.331	8.41
W172-X-ND	64.43	240.30	480.57	4	.360	9.14
W173-X-ND	103.86	388.14	776.27	6	.431	10.95
W174-X-ND	121.85	526.50	1053.00	9	.500	12.70
W175-X-ND	145.50	626.25	1252.50	11	.551	14.00
W176-X-ND	192.39	831.00	1660.50	15	.606	15.39
W177-X-ND	251.03	1080.00	2160.00	19	.646	16.41
W178-X-ND	362.79	1649.42	3299.15	27	.776	19.71
W179-X-ND	704.25	3202.35	6406.49	51	.970	24.64

Multiconductor, Stranded, PVC Insulated Cable

UL2576 Color Coded · Gray Jacket · 150 Volts · -20° to +80°C
Conductor 22 AWG-7/30 — X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Cond.	Nominal O.D. Inches	mm
W120-X-ND	9.70	34.40	56.70	2	.164	4.17
W121-X-ND	11.47	42.22	69.60	3	.169	4.29
W122-X-ND	15.31	57.69	101.00	4	.194	4.93
W123-X-ND	18.11	68.80	113.40	5	.199	5.05
W124-X-ND	27.57	109.70	174.24	6	.209	5.31
W125-X-ND	28.37	102.03	177.75	7	.214	5.44
W126-X-ND	34.58	103.28	206.55	8	.224	5.69
W127-X-ND	38.31	125.03	250.05	9	.249	6.32
W128-X-ND	42.88	145.50	291.00	10	.259	6.58
W129-X-ND	48.41	165.38	330.75	12	.279	7.09
W130-X-ND	76.00	254.48	508.95	15	.304	7.72
W131-X-ND	96.28	328.80	657.60	20	.324	8.23
W132-X-ND	106.94	411.75	823.50	25	.364	9.25
W133-X-ND	113.06	472.50	945.00	30	.379	9.63
W134-X-ND	150.08	625.50	1251.00	40	.439	11.15
W135-X-ND	176.63	783.00	1566.00	50	.500	12.70
W136-X-ND	286.12	1217.24	2386.94	60	.530	13.46

See Your FREE DIGI-KEY Catalog For Color Codes

Twisted Pair, Solid, Comm. and Control Cable

22 AWG Color Coded · Gray Jacket · UL2576 · 150 Volt
X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	No. of Cond.
W150-X-ND	9.14	30.30	60.61	1	2
W151-X-ND	16.47	58.51	98.00	2	4
W152-X-ND	21.35	81.54	134.40	3	6
W153-X-ND	28.17	101.01	177.90	4	8
W154-X-ND	31.23	106.95	213.90	5	10
W155-X-ND	35.04	118.28	236.55	6	12
W156-X-ND	50.69	176.93	353.85	9	18
W157-X-ND	63.95	228.00	456.00	11	22
W158-X-ND	71.98	257.33	514.65	13	26
W159-X-ND	86.67	304.73	609.45	15	30
W160-X-ND	109.70	461.58	834.80	16	32
W161-X-ND	109.70	381.00	762.00	19	38
W162-X-ND	111.99	462.75	925.50	23	46
W163-X-ND	123.20	528.00	1056.00	27	54

See Your FREE DIGI-KEY Catalog For Color Codes

Shrinkable Tubing, Polyolefin: Black

UL and CSA Accepted · Flame-Retarded
Self-Extinguishing · Non-Dripping

DIGI-KEY Part No.	Price Per Roll 5 Ft.	10 Ft.	50 Ft.	100 Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W180-ND	2.51	4.18	18.83	33.48	.046	.023
W181-ND	2.67	4.45	20.05	35.65	.063	.031
W182-ND	3.03	5.05	22.75	40.40	.093	.046
W183-ND	3.20	5.35	24.07	42.78	.125	.062
W184-ND	3.90	6.50	29.22	51.94	.187	.093
W185-ND	4.93	8.22	36.99	65.75	.250	.125
W186-ND	5.50	9.16	41.21	73.26	.375	.187
W187-ND	6.20	10.33	46.49	82.65	.500	.250
W188-ND	8.28	13.80	62.10	110.40	.750	.375
W189-ND	11.61	19.35	87.09	154.82	1.000	.500
W190-ND	20.83	34.72	156.22	277.73	1.500	.750
W191-ND	28.74	47.90	215.58	383.25	2.000	1.000
W192-ND	45.54	75.90	341.54	607.18	3.000	1.5000
W193-ND	66.35	110.59	497.66	—	4.000	2.000

Adhesive Wall Shrinkable Tubing: Black

MIL-I-23053/4B Class 2 - Flame-Retarded
Self-Extinguishing - Waterproof

DIGI-KEY Part No.	Price 4 Ft.	Pak/Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W200-ND	9.29	185.16/100	.250	.125
W201-ND	10.34	206.86/100	.375	.187
W202-ND	12.20	48.78/20	.500	.250
W203-ND	18.84	73.52/20	.750	.375
W204-ND	23.29	93.16/20	1.000	.500
W205-ND	33.18	132.70/20	1.500	.750

Self-Encapsulating Caps: Black

Inexpensive Method of Encapsulating Electrical Connections or Sensors

DIGI-KEY Part No.	Price/Pak Of 10	100	1,000	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W210-ND	.91	7.58	45.47	.125	.023
W211-ND	1.22	10.21	61.26	.187	.060
W212-ND	2.11	17.60	105.60	.250	.080
W213-ND	3.80	31.65	190.00	.375	.090
W214-ND	6.38	53.18	319.10	.500	.090

D-Subminiature Connectors

9, 15, 25, 37, and 50 contact solder pot contacts. Accommodates up to 20 AWG standard wire. Current Rating of 5 Amps. Contacts: Pin, copper, alloy, gold over nickel plate, Socket, phosphore bronze, gold over nickel plate. Temperature Range: -55° to +120°C

DIGI-KEY Part No.	Style	1	10	100	1,000
1S9P-ND	9 Pin Male	1.65	13.50	120.00	900.00
1S9S-ND	9 Pin Female	2.18	17.78	158.00	1185.00
1S15P-ND	15 Pin Male	2.20	18.00	160.00	1200.00
1S15S-ND	15 Pin Female	3.03	24.75	220.00	1650.00
1S25P-ND	25 Pin Male	3.00	24.53	218.00	1635.00
1S25S-ND	25 Pin Female	4.42	36.23	322.00	2415.00
1S37P-ND	37 Pin Male	4.13	33.75	300.00	2250.00
1S37S-ND	37 Pin Female	6.19	50.63	450.00	3375.00
1S50P-ND	50 Pin Male	5.25	42.98	382.00	2865.00
1S50S-ND	50 Pin Female	8.20	67.05	596.00	4470.00
HD9-ND	9 Pin Hood	1.62	13.50	108.00	810.00
HD15-ND	15 Pin Hood	1.62	13.50	108.00	810.00
HD25-ND	25 Pin Hood	1.62	13.50	108.00	810.00
HD37-ND	37 Pin Hood	1.80	15.00	120.00	900.00
HD50-ND	50 Pin Hood	2.01	16.75	134.00	1005.00

The Digi-Key volume discount and handling charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when check or money order accompanies order.

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HANDLING CHARGES		VOLUME DISCOUNT	
$ 0.00-$ 9.99	Add $2.00	$ 0.00-$ 99.99	NET
$ 10.00-$25.00	Add $0.75	$ 100.00-$249.99	Less 10%
$ 25.00-$49.99	Add $0.50	$ 250.00-$499.99	Less 15%
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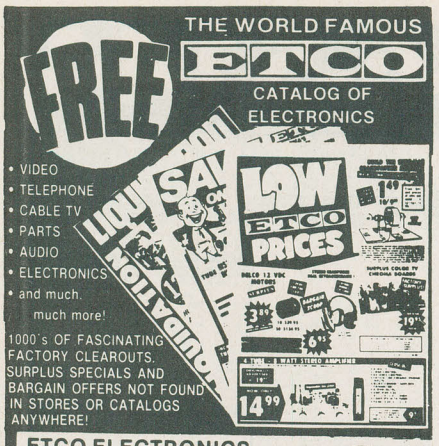

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continued from page 110

asynchronous or synchronous operation, respectively).

Pin 5 is the tie-point for R_x and C_x, which control the frequency or repetition rate of the sawtooth. The average discharge-time is 4 μs for a 0.1 μF timing capacitor. The sawtooth repetition rate is determined from the formula $1.44/(R_xC_x)$, where C_x is in μF and R_x is in megohms.

Pin 6 is the ground terminal for the device.

Pin 7 is the output of the driver amplifier. It will directly drive the grid of a vacuum-fluorescent display. In addition, it can source 50 mA at a minimum voltage of V_{CC} − 4 volts, and can sink 20 mA with a maximum of 0.4 volt. Incandescent lamps and 7-segment numeric displays require additional interfacing components.

Pin 8 is the input terminal for supply voltage V_{CC}, which can range from 4.5 to 24 volts DC. Supply current is around 12 mA and is relatively constant over the operating-voltage range when in total darkness. Supply current increases with light intensity.

Ambient-light controller

Figure 3 is a circuit you can use to keep the ambient indoor light level constant. For example, it can be used when you must increase the artificial indoor lighting level to compensate for a decrease in incoming natural light. The brightness of an incandescent light source is controlled by varying its duty cycle through a power triac. The triac, in turn is controlled by the OPL 3010 optoelectronic triac-driver. When that is done, the OPL 100 controller must be synchronized with the AC power line to ensure proper triggering of the power triac. That is accomplished by developing a sync pulse from the secondary winding of a small 6–12-volt transformer and a 1N4001 diode in the circuit between pin 4 and V_{CC}.

The 100K pot sets the ambient light level by establishing a constant current through transistor Q1. The photodiode sensor in the OPL 100 then sets the output duty-cycle to a point that produces enough light to generate an amplified light-current (I_P) at pin 1 that is equal to the current through Q1. As the incoming light fades, the output duty cycle is altered to increase the "on" time of the indoor incandescent lighting to keep the ambient light level constant.

This item was prepared from material supplied by TRW Optron. If you'd like additional information on the OPL 100 Automatic Brightness Controller, write to TRW Optron, 1201 Tappan Circle, Carrollton, TX 75006 and ask for Product Bulletin 2091 and Application Bulletin 115. **R-E**

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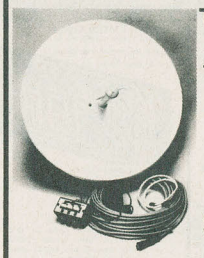

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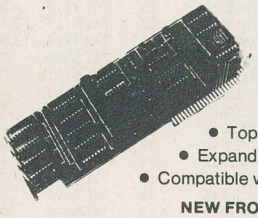

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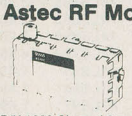

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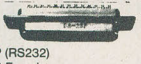

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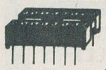

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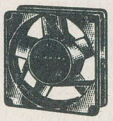

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7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00	$ .26	74LS113	$ .43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

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4007	.25	4043	.85	4099	2.25
4008	1.39	4044	.85	14408	12.95
4009	.45	4046	1.75	14409	12.95
4010	.45	4047	1.25	14410	12.95
4011	.35	4048	.99	14412	12.95
4012	.25	4049	.45	14415	9.95
4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	.89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	.95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
4032	2.15	4081	.35	80C95	1.50
4034	3.25	4082	.35	80C97	1.25
4035	.95	4085	1.95		

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STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
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2111	256 x 4	(450ns)	2.49
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2114L-2	1024 x 4	(200ns) (LP)	8/13.95
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TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2764	8192 x 8	(450ns) (5v)	9.95
2764-250	8192 x 8	(250ns) (5v)	14.95
2764-200	8192 x 8	(200ns) (5v)	24.95
TMS2564	8192 x 8	(450ns) (5v)	17.95
MC68764	8192 x 8	(450ns) (5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95

6.0 Mhz

Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
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6847	11.95
MC1372	6.95
68047	24.95
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8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
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8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8231	call
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

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1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	14.95

UARTS

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MM5307	10.95

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XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	.99
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	.99
74LS113	.39	74LS374	.99
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
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74LS166	1.95	81LS97	1.49
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7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
		CA 3160	1.19

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
	75494	.89	

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
	LF357	1.40	

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
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4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
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74S04	.35	74S174	.95
74S05	.35	74S175	.95
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74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.08
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.49	.49
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

VOLTAGE REGULATORS

7805T	.75	7905T	.85
7808T	.75	7908T	.85
7812T	.75	7912T	.85
7815T	.75	7915T	.85
7824T	.75	7924T	.85
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
78H05K	9.95	LM323K	4.95
78H12K	9.95	UA78S40	1.95

T = TO-220 K = TO-3
L = TO-92

LED LAMPS

	1-99	100-up
Red	.10	.09
Green	.18	.15
Yellow	.18	.15

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

ULN2003	2.49
3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

INTERSIL

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ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

EXAR

XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

DATA ACQUISITION

ADC0800	15.55	DAC0808	2.95
ADC0804	3.49	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
ADC0817	9.95	MC1408L6	1.95
DAC0800	4.95	MC1408L8	2.95

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AY3-8912	12.95
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- ★ COLOR MATCHES APPLE
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- ★ INCLUDES MOUNTING HARDWARE AND FEET

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RS232 FEMALE RIGHT ANGLE	5.25
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MCA-255	1.75
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ILA-30	1.25
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H11C5	1.25
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TIL-113	1.75
4N26	1.00
4N27	1.10
4N28	.69
4N33	1.75
4N35	1.25
4N37	1.25
MCT-2	1.00
MCT-6	1.50

TRANSISTORS

2N918	.50	2N3772	1.85
MPS918	.25	2N3903	.25
2N2102	.50	2N3904	.10
2N2218	.50	2N3906	.10
2N2218A	.50	2N4122	.25
2N2219	.50	2N4123	.25
2N2219A	.50	2N4249	.25
2N2222	.25	2N4304	.75
PN2222	.10	2N4401	.25
MPS2369	.25	2N4402	.25
2N2484	.25	2N4403	.25
2N2905	.50	2N4857	1.00
2N2907	.25	PN4916	.25
PN2907	.125	2N5086	.25
2N3055	.79	PN5129	.25
3055T	.69	PN5139	.25
2N3393	.30	2N5209	.25
2N3414	.25	2N6028	.35
2N3563	.40	2N6043	1.75
2N3565	.40	2N6045	1.75
PN3565	.25	MPS-A05	.25
MPS3638	.25	MPS-A06	.25
MPS3640	.25	MPS-A55	.25
PN3643	.25	TIP29	.65
PN3644	.25	TIP31	.75
MPS3704	.15	TIP32	.79
MPS3706	.15		

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1N759	12.0 volt zener	.25
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1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55

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D-SUBMINIATURE

DESCRIPTION	SOLDER		RIGHT ANGLE SOLDER		RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DB**xx**P	DB**xx**S	DB**xx**PR	DB**xx**SR	IDB**xx**P	IDB**xx**S	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	---	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	---	2.95
50	6.06	9.24	---	---	---	---	---	3.50

For order instructions see "IDC Connectors" below.

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.50	4.40	.83	7.30
20	.65	5.70	1.25	11.00
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDH**xx**S	IDH**xx**SR	IDH**xx**W	IDH**xx**WR	IDS**xx**	IDM**xx**	IDE**xx**
CONTACTS 10	.82	.85	1.86	2.05	1.15	---	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

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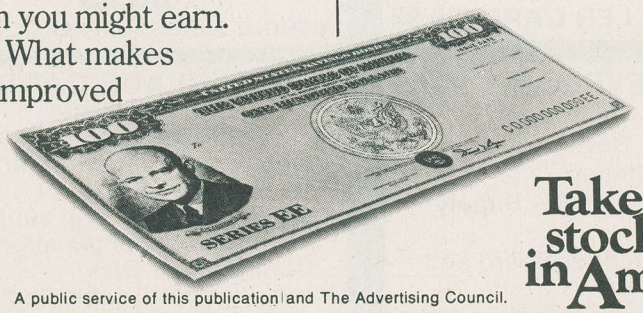

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74LS08N	35	74LS107N	40
74LS10N	25	74LS112N	45
74LS13N	45	74LS113N	45
74LS14N	99	74LS132N	75
74LS20N	25	74LS136N	49
74LS22N	25	74LS151N	75
74LS28N	35	74LS155N	79
74LS30N	25	74LS157N	75
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74LS107N	40		
74LS112N	45		
74LS113N	45		
74LS132N	75		
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14	.14	24	.30
16	.16	28	.40
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20	.29	40	.49

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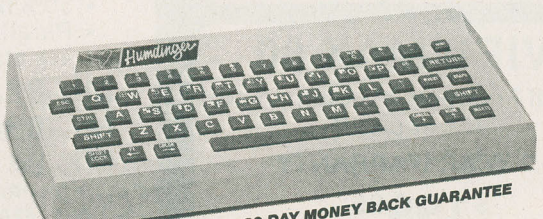

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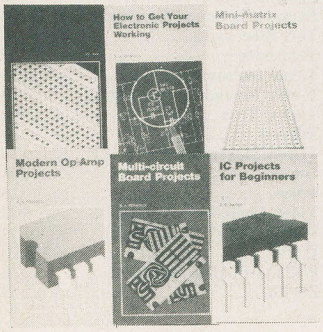

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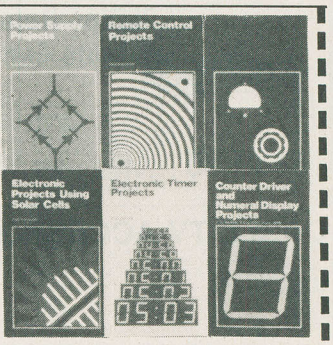

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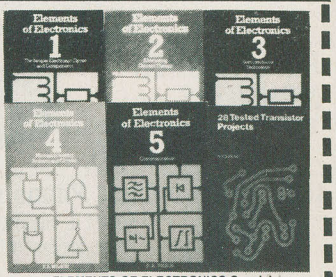

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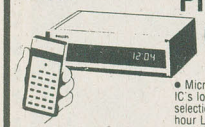

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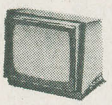

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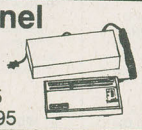

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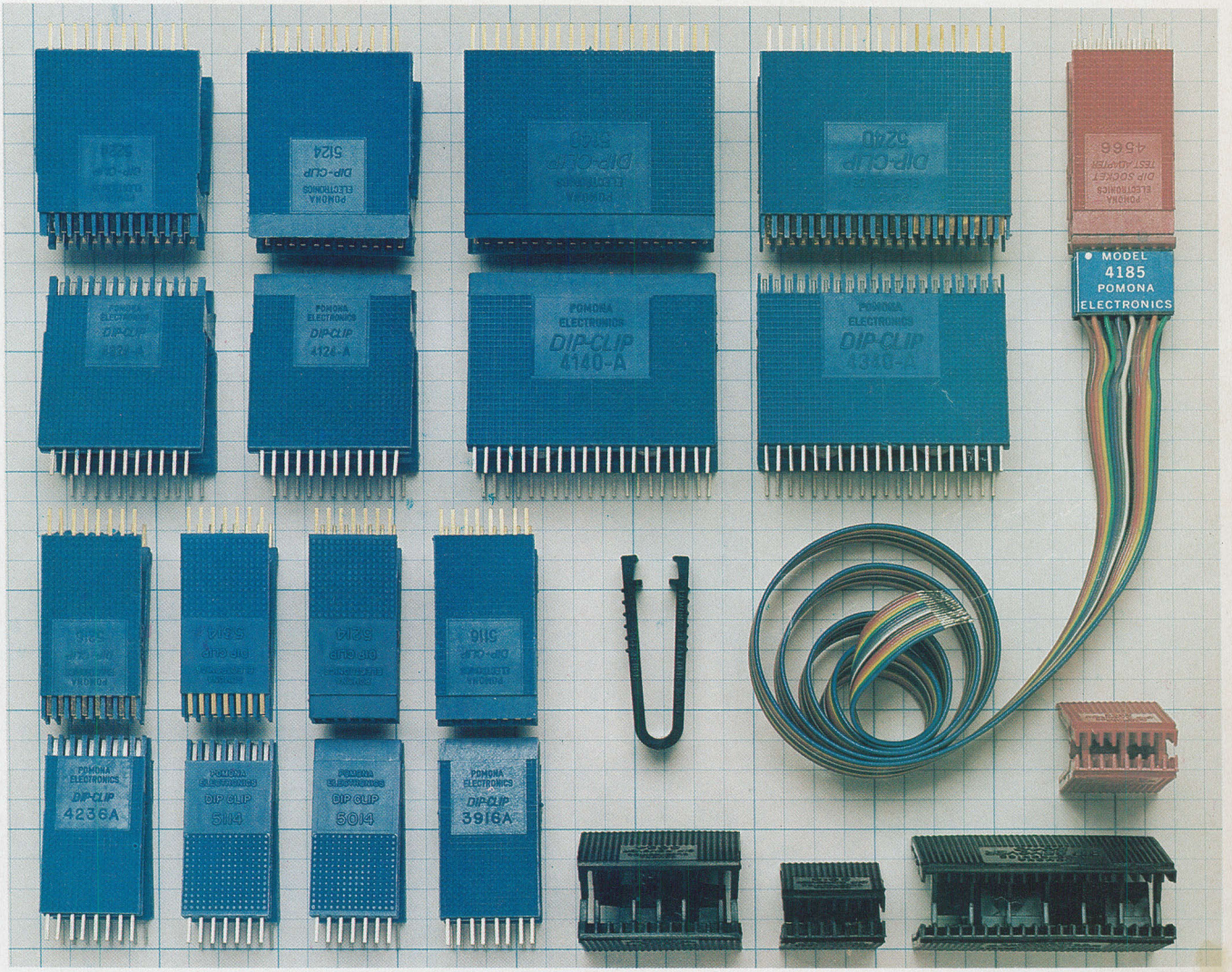

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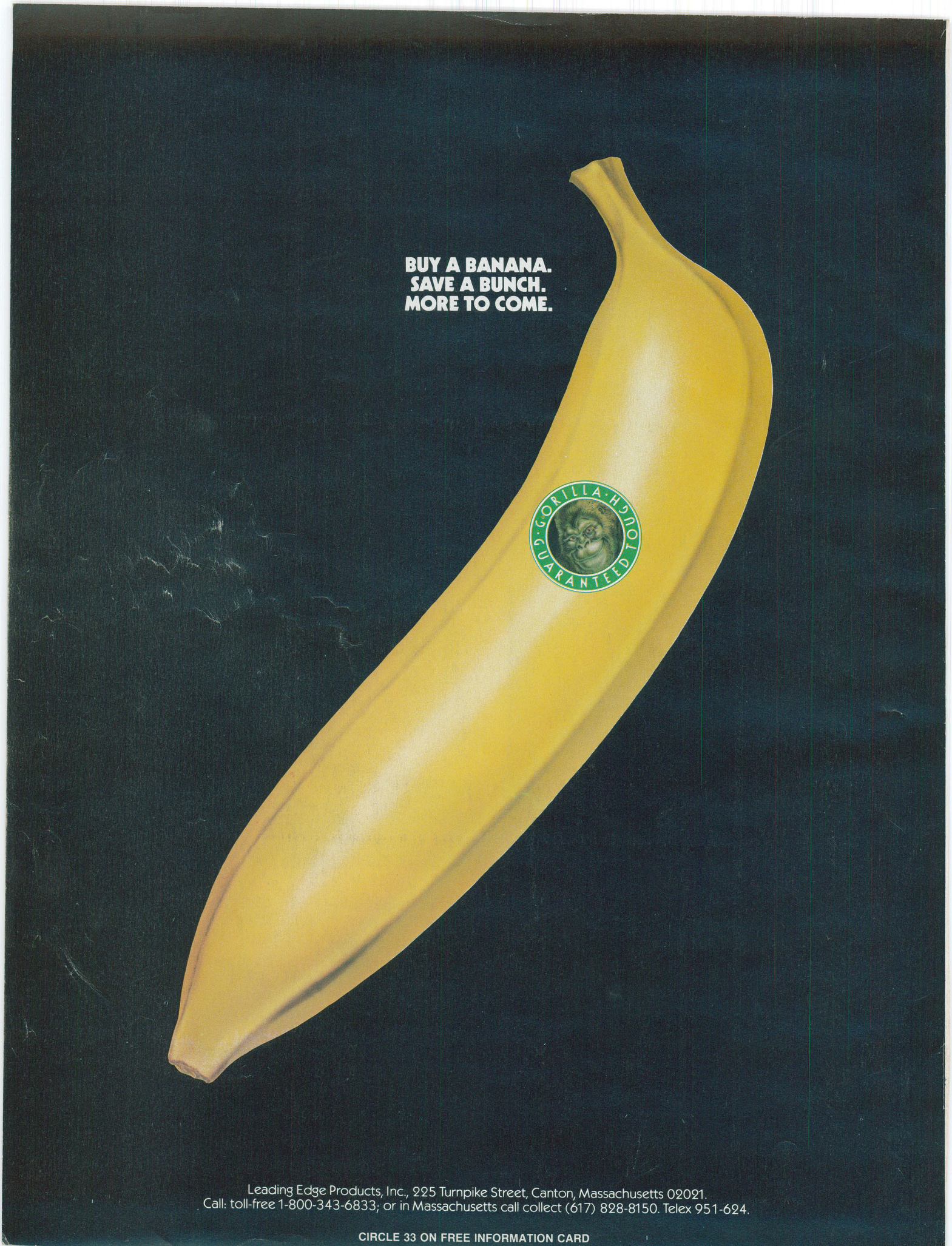

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